TECHNICAL AND COST PROPOSAL

Proposal No. 23074-G
April 12, 1983

DEVELOPMENT AND TESTING OF PCB—SILT DECONTAMINATION PROCESS

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
Great Lakes National Program Center
536 South Clark Street
Chicago, IL 60605

Franklin Research Center
A Division of The Franklin Institute
The Benjamin Franklin Parkway, Phila. Pa. 19103 (215) 448-1000

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SUMMARY

A new approach is presented to the problem of dealing with PCB-laden river and harbor bottom sediments. This approach does not involve the dredging and transport of the contaminated sediment. The proposed process consists of extraction of the PCBs in situ from the sediment, followed by treatment of the extract with NaPEG^{tm} to destroy the PCBs. The solvent will be recycled to the extractor.

This proposal describes the laboratory work necessary to provide an engineering basis for the design of a pilot-scale unit. This unit will serve to demonstrate the process and to pinpoint specific operating conditions to be used in the large-scale operation.

The design of the pilot unit will be carried out as part of the presently proposed work but the construction and operation of the pilot unit would be carried out under a projected follow-on contract.

1. INTRODUCTION

The PCB-contamination problem in the harbor at Waukegan, Illinois is probably the worst in the United States, in terms of PCB concentration levels and total quantity of PCBs. Dredging the contaminated silt from the harbor and transporting it to a landfill site is, to many, an unacceptable solution, because the risk of ultimately contaminating ground water is not eliminated.

The Franklin Research Center's potential solution to the problem was previously described by Mr. David M. Kyllonen in an oral presentation at the EPA offices in Chicago, Illinois on January 27, 1983. The proposed method would not require transport of contaminated sediment.

2. GENERAL DESCRIPTION OF CONCEPT AND OF PROPOSED WORK

2.1 THE CONCEPT

The proposed scheme is an integrated two-step operation. In the first step, mineral oil is pumped through the sediment, in situ, under closely-controlled conditions to extract the PCBs from the sediment. The oil rises to the surface of the water; it is then pumped off to be recycled to the extractor or to be sent to the second step. In the second step the mineral oil-PCB solution is treated with NaPEG™ reagent at a shoreside location. Franklin has already established the viability of the NaPEG™ process for treating transformer oils containing PCBs. (See Appendix for further details on the EPA demonstration runs and current license status).

The clean mineral oil is then available to be used again in the in-situ extraction unit in the harbor, to collect more PCBs.

A schematic view of the in-situ extractor is shown in Figure 1.

A schematic flow sheet that shows the integrated process for extraction and destruction of PCBs is shown in Figure 2.

2.2 GENERAL DESCRIPTION OF PROPOSED WORK

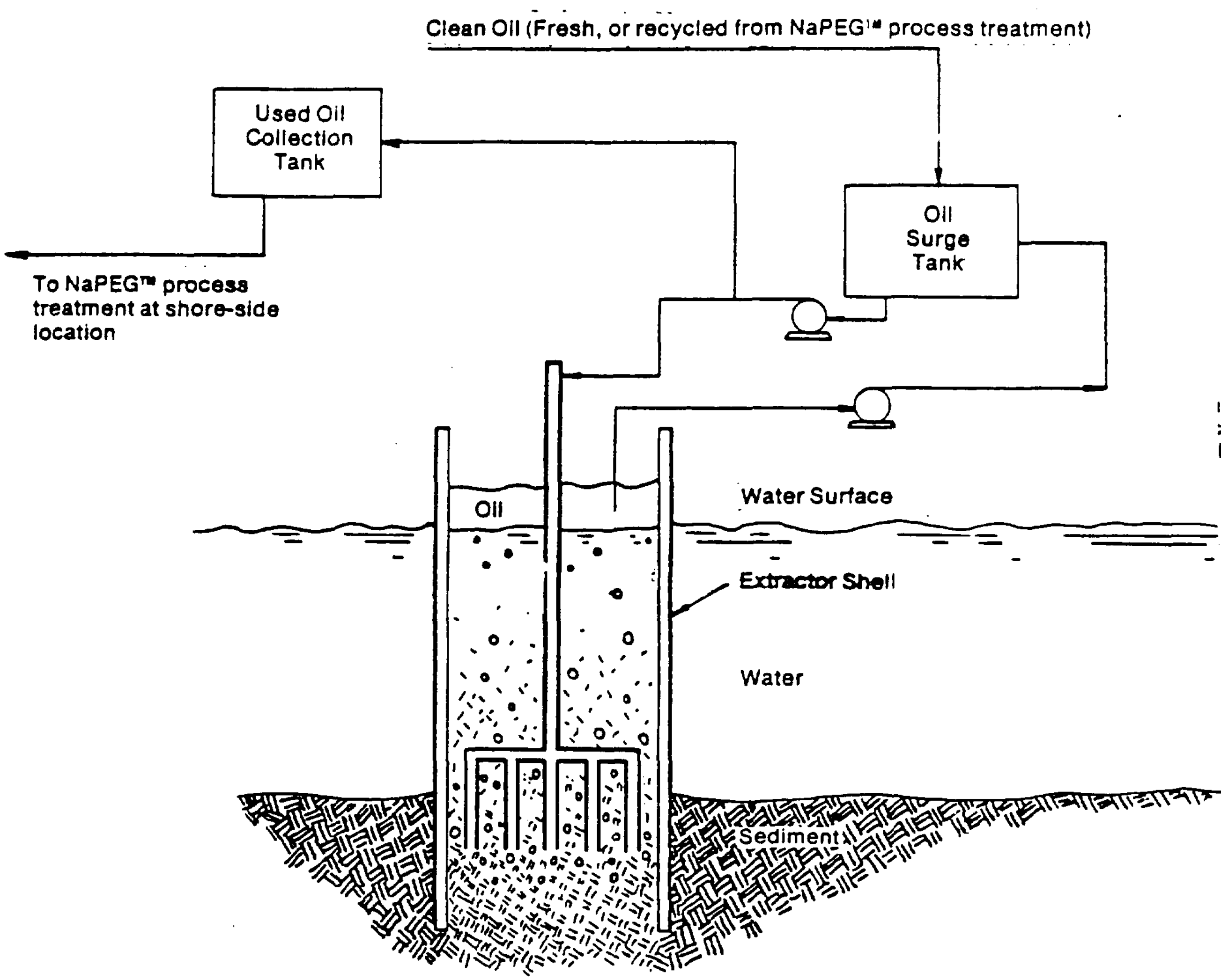
It has already been established by studies in our laboratory that it is possible to extract PCBs from harbor or river bottom sediment with mineral oil in the presence of water.

In order to establish an engineering basis for the design of an in situ extraction system, it will be necessary to develop, through laboratory studies, information in the following areas:

a. Physical characteristics of the sediment relative to oil and water.

b. Equilibrium distribution data for PCBs in the oil-sediment system.

c. Studies of the rate of extraction of PCBs from sediment using mineral oil as the solvent.



Note: Undisturbed sediment serves as bottom of extractor.

Figure 2-1. Extraction Scheme for Removal of PCBs from Harbor Sediment Using Mobile Extractor Unit

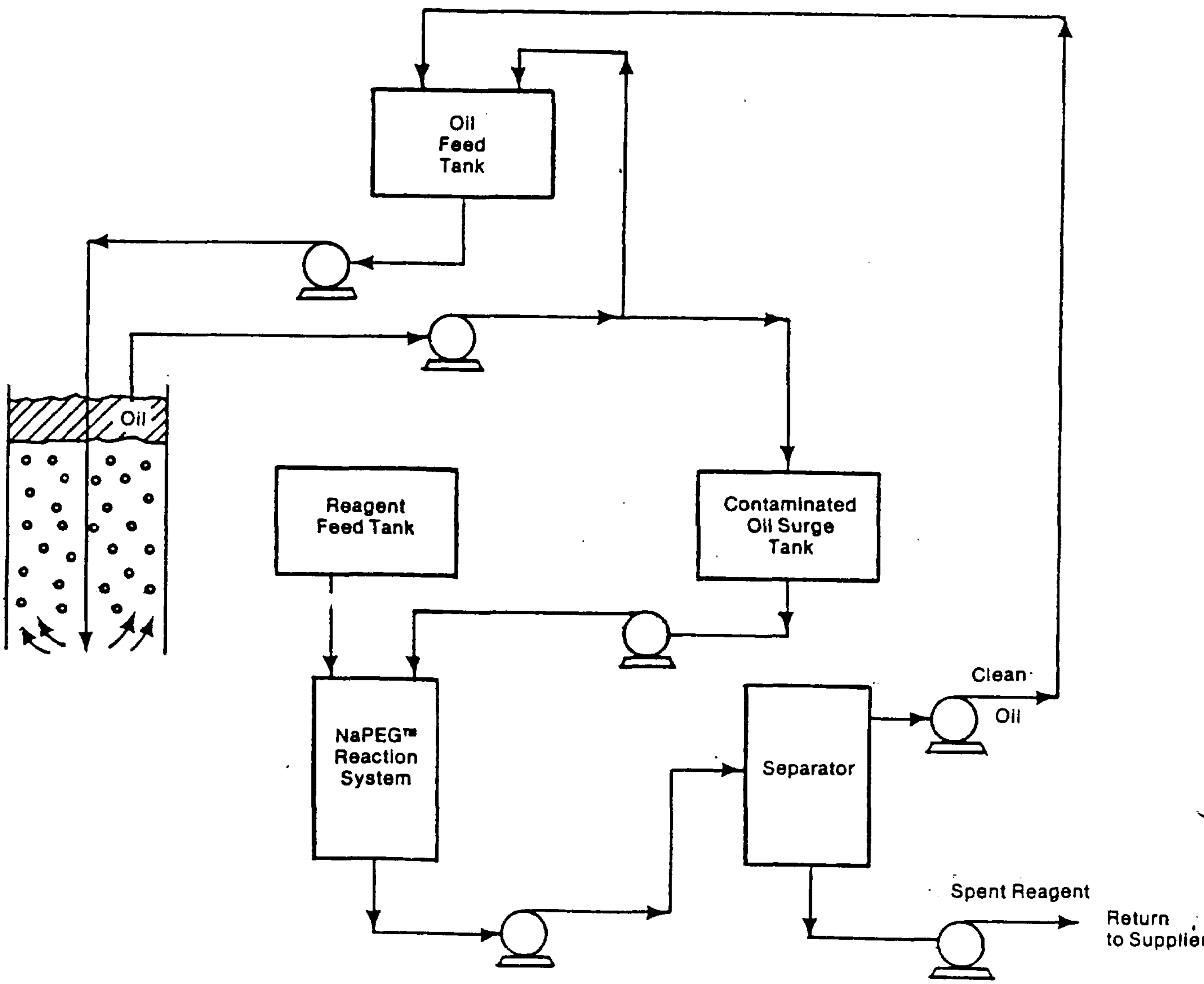


Figure 2-2. Integrated Process for Removal and Destruction of PCBs from Harbor Sediment

Upon completion of the laboratory studies, work will begin on the design of the extractor and the selection of the auxiliary equipment needed for the pilot plant tests. A cost estimate of pilot plant equipment will be prepared together with an estimate of the cost of constructing the unit and carrying out pilot plant operations.

The Gantt chart, Figure 3, showing the estimated times for the proposed activities also shows the estimated times for carrying out the construction and operation of the pilot plant unit. These latter two items will be the subject of a follow-on proposal, if desired.

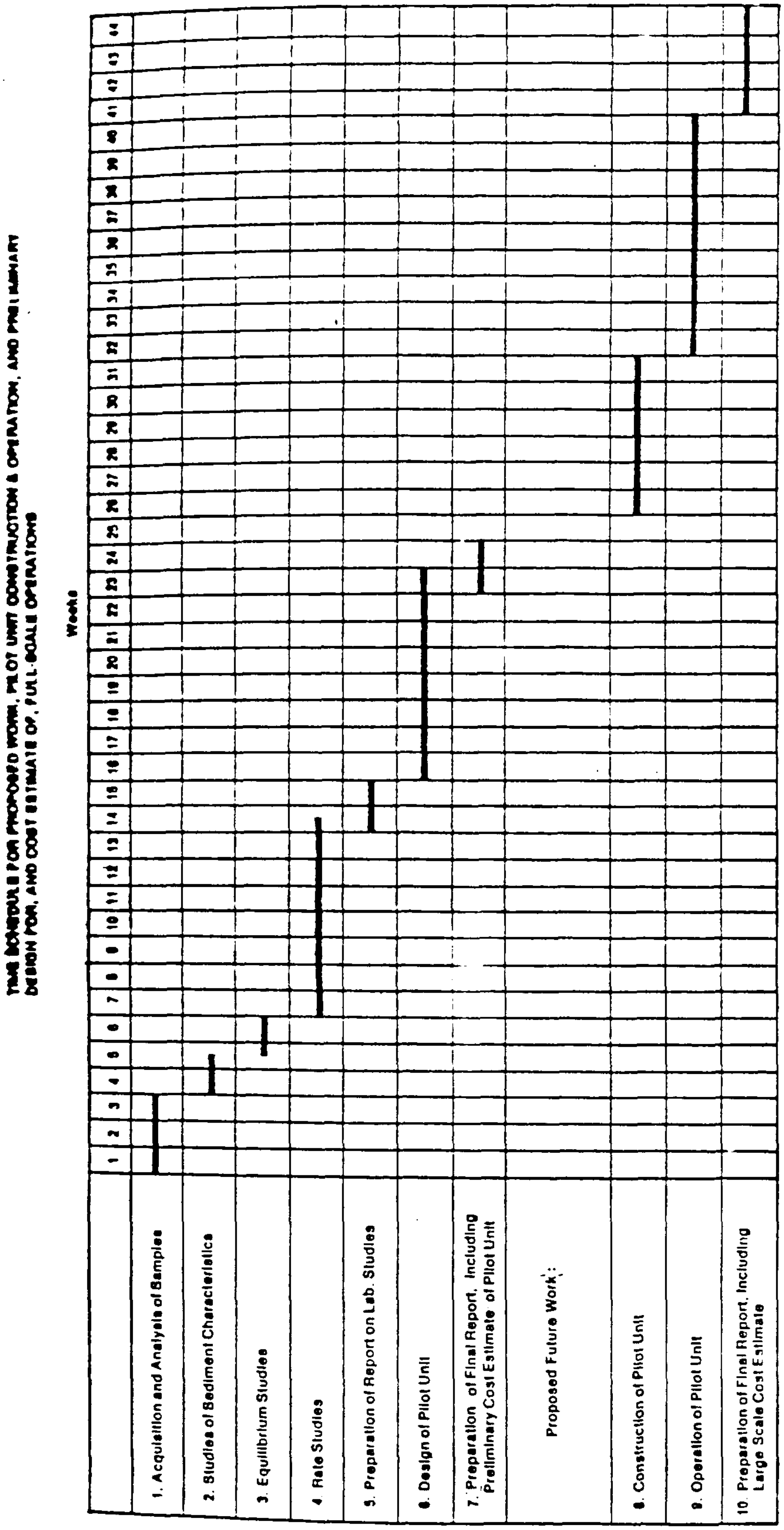


Figure 2-3. Time Schedule for Proposed Work, Pilot Plant Construction and Operation, and Preliminary Design for, and Cost Estimate of, Full-Scale Operations

3. LABORATORY STUDIES

3.1 GENERAL

The laboratory work will consist of two stages. In the first stage, the physical characteristics of the sediment will be studied. This information will provide the basis for the design of the extractor unit. In the second stage, equilibrium and rate data will be obtained using sediment samples from the Waukegan site. This will be used as the basis for equipment specifications and operating conditions.

A certain quantity of sediment material from the Waukegan Herbor will be needed for the laboratory studies. It will be desirable to obtain samples over a wide range of PCB concentration levels for that work. Information from previous sampling and analysis by others will be used as a guide in establishing the locales for drawing material from the harbor.

The analysis of these sediment samples will be carried out at the Franklin Research Center laboratories.

3.2 SEDIMENT CHARACTERIZATION

There will be two parts to this stage. The first part will deal with oil entrainment in the sediment. In the second part, the bulk properties of the sediment will be investigated with respect to settling characteristics and ease of agitation.

3.2.1 Oil Entrainment

The purpose of this work is to measure the relative affinities of the sediment for oil and water. A specified amount of clean, moist sediment will be thoroughly saturated with a measured amount of oil. Sufficient water will then be added to the system to separate the unentrained oil from the sediment. After the mixture is allowed to stratify, the oil layer will be withdrawn. The quantity of entrained oil per unit volume of sediment may then be determined from the original amount of oil used.

3.2.2 Physical (bulk) Characteristics of Sediment

A system consisting of clean sediment and water will be agitated so that the sediment is completely dispersed throughout the water. The mixture will then be allowed to settle, with qualitative observations being made at regular intervals. Qualitative studies will also be carried out to evaluate the relative efficiencies of various methods of agitating the sediment. In this case, a settled bed of sediment in water will be agitated using one of the following:

1) Propeller agitator
2) Oil feed through regularly-spaced tubes
3) Compressed-air feed through regularly-spaced tubes

3.3 EXTRACTION STUDIES

Equilibrium and rate studies will be conducted under favorable conditions to establish standards against which the performance of the pilot- and full-scale units may be compared.

3.3.1 Equilibrium

A mixture of moist sediment and oil will be thoroughly mixed and allowed to stand, undergoing periodic agitation. During the first three runs (one each at a low, a medium, and a high concentration of PCB), oil samples will be withdrawn at regular intervals, filtered, and analyzed for PCB content. The time required to reach equilibrium will be noted and used in later runs, in each of which only two oil samples will be taken. A sufficient number of different PCB concentrations will be used to ensure accurate data over the full range of working concentrations.

3.3.2 Rate

The object of the rate studies will be to establish the most efficient operating conditions for the process. The extraction vessel will contain a propeller-type agitator to ensure adequate contacting between oil and sediment. A mixture of sediment and water will be introduced into the extractor and continuously agitated. Clean oil will then be pumped into the bottom of the extractor through feed tubes mounted on the sides of the vessel. Samples will be regularly withdrawn from the oil layer at the top of the vessel, filtered, and analyzed for PCB content.

A metering pump will be used so that various oil flowrates may be used. The temperatures of the water and the feed oil will also be varied, to evaluate temperature effects on the extraction. The full range of concentrations will be covered.

4. PILOT-SCALE STUDIES

4.1 GENERAL

In anticipation of future work involving the construction and operation of a pilot-scale extraction system at the Waukegan site, the design for a pilot unit and supporting equipment is included as part of the work in the present proposal. The actual pilot-scale work, not included in this proposal, will serve to 1) verify the data obtained in the laboratory, and 2) pinpoint possible difficulties to be dealt with in the full-scale operation.

4.2 DESIGN

The extractor shell will consist of a three-foot-diameter pipe. The specifics of the pilot plant design with regard to methods of oil feed and agitation, oil flowrate, temperature control, and equipment sizing will be based on the laboratory studies.

5. FINAL REPORT

5.1 Upon completion of the laboratory studies and the design work on the pilot unit, a final report will be prepared. This report will include a cost estimate for the construction and operation of a pilot unit.

6. PROJECTED FUTURE WORK

6.1 CONSTRUCTION AND OPERATION OF PILOT UNIT

Estimated time schedules for the construction and operation of the pilot unit are shown on the Gantt chart (Figure 3), although the work is not included in this proposal.

6.2 REPORT ON PILOT ACTIVITIES AND COST PROJECTION OF LARGE-SCALE OPERATION

Following completion of the pilot operations, a final report will be prepared which will include a preliminary cost estimate for the large-scale treatment of the Waukegan Harbor sediment.

7. PERTINENT PROJECT EXPERIENCE

7.1 BACKGROUND

Franklin Research Center has a long history of projects conducted for public health and safety dating back to the founding of the parent institution, The Franklin Institute, more than 150 years ago. Even before Franklin Research Center became a separate division in 1946, this laboratory was heavily involved with the United States defense effort, supporting the military establishment throughout World War II with projects in munitions, weaponry, explosives, and chemicals. Since 1946, there has been a heavy concentration of FRC's work in the areas of chemicals and hazardous materials, and the Center has maintained its position of world leadership in fields as explosives and pyrotechnics to the present day. Projects have included everything from concept, research, and development of unique new chemicals to comprehensive literature studies synthesizing all the information available throughout the world on any given substance.

7.2 EXPERIENCE IN HANDLING HAZARDOUS MATERIALS

The Process Technology Department conducts experimental and design work on the disposal of hazardous substances. This department, which consists of chemists, chemical and process engineers, physicists, and other scientists in related fields, also develops, constructs, and operates pilot plants for industrial and governmental sponsors.

Other departments at FRC deal with different aspects of the hazardous-materials problem, and some of their pertinent work will be mentioned here. This body of related work forms a vital adjunct to the research and development provided by the Process Technology Department, bringing all of FRC's resources to bear in a systematic, multidisciplinary approach aimed at finding a solution for current hazardous materials problems.

Handling of hazardous materials is routine in some of FRC's operations. The analytic laboratories, for example, often receive samples of materials for identification. Since the contents of these specimens are unknown, all of them must be considered as hazardous until proven otherwise. For other projects, FRC receives known hazardous materials (7.5.2) for monitoring or evaluation. Furthermore, most of the work performed at FRC's chemical pilot plant facility in Elverson involves hazardous materials. The operations to make NaPEG, Reagents, the fuels handled in combustion testing, and the explosives and pyrotechnics used for Air Force projects of upper atmosphere testing all involve risk. Nevertheless, there has not been any serious accident--one requiring hospitalization--from the use of chemicals or other hazardous materials, either in the laboratory building or at the Elverson facility since these two facilities were established in 1966 and 1955 respectively.

The projects performed during Franklin Research Center's many years of work with hazardous substances can be grouped into the following categories:

- Decontamination/Neutralization of Hazardous Materials
- Disposal/Conversion/Reclamation of Wastes
- Analysis, Monitoring, and Evaluation
- Process Pilot Plants
- Information

Through the performance of these projects, Franklin Research Center has acquired a staff with extensive experience in hazardous-materials technology (Resumes, Appendix A). One hundred percent of the staff proposed for this project has experience in working with soils in field testing, and/or in scaling up projects from bench to demonstration.

Personnel at the FRC chemical pilot plant facility at Elverson deal routinely with hazardous oxidizers and fuels including hydrazine, unsymmetrical dimethylhydrazine (UDMH), boranes, liquid metals including sodium, liquid hydrogen, methyl cyanide, cyanogen, hydrogen cyanide, liquid methane, trimethyl and triethyl aluminum, titanium tetrachloride, chlorine liquid and gas (including chlorine trifluoride and pentafluoride), fluorine liquid and gas, oxygen difluoride, and nitrogen tetroxide.

7.3 DECONTAMINATION/NEUTRALIZATION OF HAZARDOUS MATERIALS

7.3.1 Chemical Destruction of PCBs and Other Hazardous Halogenated Chemicals by the NaPEG System

The NaPEG System is a chemical system developed at Franklin Research Center to dehalogenate organohalides by using NaPEG Reagents--a new family of chemicals--and a special process. Appendix C describes the system in some detail. This new technique was initiated as FRC self-sponsored research and supplemented with funds from government and industrial sponsors. Funding was obtained from the Environmental Protection Agency (Grant R806649010) to study the fundamental chemistry, and potential extensions to decomposition of such materials as Kepone, DDT, and Toxaphene were included in self-sponsored research programs. The original EPA grant has been expanded to include the dehalogeneration of PCB-contaminated spills. In addition, a contract was obtained from EPRI to investigate the removal of PCBs from transformer oil by using a combination of absorption on a substrate, solvent extraction, and treatment with NaPEG Reagent.

In October 1982, EPA Region III granted the Franklin Institute a license for the use of its NaPEG System to remove PCBs from contaminated transformer oil. This license was granted following a successful demonstration project, conducted under the auspices of Region III and jointly sponsored by FRC and Philadelphia Electric Company, that reduced levels of PCBs in dielectric oil from 7400 ppm to less than 1 ppm and also yielded reusable transformer oil. For this project, FRC developed a pilot plant (listed in 7.6), which Philadelphia Electric will use commercially. Before beginning plant operations, FRC and PECO worked with community residents to gain the cooperation and understanding of the new plant's neighbors. The Franklin Institute has applied for licenses from the other EPA regions and, to date, has been granted approval by Regions X, VI, and VIII. Region V will rule on the application only after the establishment of a disposal facility using the NaPEG^{tm} process in the geographical area comprising Region V.

Table 7-1. Recent Projects to Dehalogenate Persistent Chemicals Found in Various Media

Sponsor	Date	Project
Philadelphia Electric Company	1/81 - 10/82	Demonstrate removal of PCBs from transformer oil and yield reusable oil
SmithKline & French	2/81	Scrub methylene chloride from airstream
Amtrak	8/81	Review Amtrak's PCB Replacement Program
Allis Chalmers	9/81 - 11/81	Destroy PCBs from ash wood samples
Texas Eastern	1982	Destroy PCBs in pipeline distillate, waste sludge, and soil from pit lining
Fred Wilson and Assoc.	1/82	Treat PCB spill in Jacksonville, FL
Natural Gas Pipeline Company	1/82	Dechlorinate PCBs in distillate samples collected from natural gas pipeline
Tennessee Gas Pipeline Company	3/82	Destroy PCBs from an aromatic liquid
Carl Fahrenback Assoc.	4/82	Treat waste motor lubricant to remove PCBs and determine effect of treatment on heavy metal content
EPRI	4/82	Use poultice to clean PCB spill
Public Service Electric & Gas	7/82	Destroy PCBs in dielectric fluids
Self-sponsored	9/82	Remove heavy metals from shale oil
City of New Bedford	9/82	Extract PCBs from river silt
Amtrak	10/82	Extract and destroy PCBs from car shop soil samples
Haws and Burke	1/83	Destroy pentachlorophenol from creosote oil

Table 7-1. Recent Projects to Dehalogenate Persistent Chemicals Found in Various Media (Continued)

Sponsor	Date	Project
Union Camp	10/82	Desulfurize turpentine and related mixtures
Cannelton Industries	in progress	Extract PCBs from coal waste
EPRI	in progress	Adsorp PCBs from transformer oil
EPA	in progress	Destroy PCBs in soil

Additional NaPEG System research, under industrial and governmental sponsorship, has been focused on the dehalogenation of toxic chemicals found in a variety of media such as soil, sand, sludge, wood, ash, and distillates (Table 7-1); dehalogenation of industrial effluents containing halogenated herbicides; and control of industrial emissions containing halogenated solvents.

7.3.2 Neutralization of Simulated Chemical Agents has been researched by FRC in classified projects sponsored by the Department of Defense.

7.4 DISPOSAL/CONVERSION/RECLAMATION OF WASTES

7.4.1 Codisposal of municipal sewage sludge and incinerator residues, and their conversion to an aggregate for highway paving, are accomplished by the ECOROCK process, which is being funded by the EPA and the City of Philadelphia. This project began with a series of grants and contracts on incineration/encapsulation of incinerator residue (EPA/DOT), culminating in a pilot plant project (see 7.6) to produce the aggregate material. A large semiworks unit has been completed for the City of Philadelphia's Water Department and is presently in an operational startup phase with the official opening scheduled for early 1983.

7.4.2 DOE approved a project to combine waste deciducus leaves and reclaimed industrial waste plastics, forming a composite, solid, alternative fuel called PL-Fuel. (The conversion of these wastes into a useful product had been funded under DOE's Synfuels II program, but funding was eliminated. Private financing is being sought to continue this program.)

7.4.2 Other Projects:

- o Densifying and converting municipal incinerator residue into useful construction materials (EPA, Bureau of Solid Waste Management)
- o Development and demonstration of process for recycling paper from rubbish (EPA, Bureau of Solid Waste Management; Industrial Sponsors)
- o Development of <u>disposal techniques</u> for nylon wastes, polypropylene wastes, mining wastes (Industrial Sponsors)

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- o <u>Recovery and reuse</u> of metals such as copper (from waste materials), base and precious metals (from scrapped electronic equipment) (Industrial Sponsors).
- o Study of the ecological effects of <u>ocean dumping</u> of sewage sludges (City of Philadelphia; Federal Water Quality Administration)

7.5 ANALYSIS, MONITORING, AND EVALUATION

7.5.1 <u>Analysis</u> not only encompasses the routine laboratory studies, but also includes field studies and the development of new analytical procedures. FRC has developed some of the current standard test procedures for asbestos and has pioneered new analytical methods for PCBs, military emissions (ion mobility spectrometer), formaldehyde, and water pollutants (army field test kit). The Research Center is also developing new methods for analysis of trace quantities of metals using Mossbauer spectroscopy.

In a recent field study, FRC was called to find the source of contamination of wells used for process and drinking water at a local manufacturing site. The wells were contaminated by chlorinated hydrocarbons, chiefly trichloroethylene and 1, 1, 1-trichloroethane. FRC conducted a site study to locate sampling points for surface water and soil, collected samples, and tested the samples quantitatively for various chlorinated hydrocarbons. Based on the site survey, the distribution of contaminants, and the topography and subsurface geological structure of the site, the source of the contamination was pinpointed. FRC reported the probable cause for the presence of the deep-well contaminants to its sponsor in this rural Pennsylvania community.

7.5.2 <u>Monitoring of hazardous materials</u> is done routinely by FRC for industrial sponsors to check various effluents and environmental emissions. Current and recent work has focused on EPA Priority Pollutants, PCBs, trichloroethylene, asbestos, air emissions in foundries, and formaldehyde from foam insulation.

7.5.3 <u>Evaluation</u> at FRC covers a wide range of operations, from new product studies to a literature search examining "Novel Underground Transport

Systems," a search concerning soil-handling techniques applicable to topsoil, base material, and pyritic material removal for opencast mining.

7.7 PROCESS PILOT PLANTS

The FRC's Process Technology Department and three Engineering Departments have many years of experience in pilot-plant design and evaluation of chemical and mechanical processes.

Recently completed projects example, include:

- NaPEG treatment plant--demonstration pilot plant for the destruction of PCBs in transformer oils; built and operated at the Philadelphia Electric Company's maintenance depot;

- ECOROCK, a multimillion-dollar semiworks unit for codisposal of municipal sewage sludge and incinerator residue and its conversion to a construction aggegate, by the ECOROCK process. This facility is located adjacent to one of the sewage treatment plants of the City of Philadelphia (EPA and City of Philadelphia);

- Pilot plant production of construction aggregate from incinerator residue by the ECOROCK process, which produced tonnage quantities of product for installation of an experimental demonstration highway (Department of Transportation);

- Aquaculture pilot plant for cultivation of fish in the warm water effluent of a fossil-fuel-fired electrical generating plant, piloted for a major food supplier;

- Franklin Fiber (a proprietary FRC product), needle-like fibers of calcium sulfate which were piloted for and licensed to a major manufacturer of construction materials;

- Several pilot-scale projects that evaluated new processes for recovery of metals (precious metals, nickel, zinc, lead) and for purification of metallic salts (for Industrial Sponsors); and,

- Previous and current projects to develop food-handling and production processes for large food-processing facilities.

The FRC chemical piloting facility is located in Elverson, Pennsylvania in a rural setting. Current piloting projects at that location include a process for production of specialty amines, a semiworks unit for production of NaPEG Reagent, a facility for the assembly of pyrotechnics, and a unit for formulation and combustion of alternate fuel mixtures (including COM).

7.8 INFORMATION MANAGEMENT

FRC's Information Management Department (IMD) has in-depth knowledge and extensive expertise in projects involving the collection and synthesis of environmental and toxicological information. Staff members conduct literature research and compile data to prepare evaluative monographs on toxicological effects of chemicals or radiation, the effects of air and water pollutants, solid-waste management, carcinogenesis, and other environmental and occupational-health topics.

IMD has worked extensively for the Environmental Protection Agency (EPA) and the National Institute for Occupational Safety and Health (NIOSH) and has also served other government and private sponsors on projects of the foregoing nature. Some examples of this work include the following:

- investigative reports and hazard analysis on selected industrially important chemicals (for EPA);
- an evaluation of the applicability of structure-activity correlation methods for use as early-warning indicators of the potential health and environmental hazards of toxic substances (for EPA);
- profiles of the physical and chemical properties, toxicology, and environmental fate and effects of 41 pollutant substances (for EPA);
- state-of-the-art reviews on environmental pollution relating to land/sea waste-disposal methods (for EPA);
- criteria documents on pulp and paper mills, secondary aliphatic monoamines, tertiary aliphatic monoamines, dichloropropanes, trichloropropanes, monohaloacetic acids, and occupational exposure to ultraviolet radiation (for NIOSH);
- profiles on the health and safety hazards encountered in 22 industrial processes (for NIOSH);
- current-awareness services on analytical and sampling techniques for coal-tar-pitch volatiles and on the approximately 400 substances on the *Federal Register* list of toxic agents (for NIOSH);
- review, analysis, and monograph preparation concerning the toxicity, biology, and chemistry of selected chemicals used in consumer products (for the Consumer Product Safety Commission);

- problem-definition studies on the occupational-health and environmental effects of a series of chemicals (for the U.S. Army Medical Research and Development Command);
- monographs on 1-hexene and 1 butene (for the Society of the Plastics Industry);
- a state-of-the-art review of the toxicology and metabolism of the food additive, butylated hydroxytoluene (for the Manufacturing Chemists Association); and
- a complete review of methods for estimating carcinogenic potency (for the National Cancer Institute).

8. MANAGEMENT PLAN

8.1 TECHNICAL RESPONSIBILITY

FRC will use its existing management system to carry out proposed work assignments. The system is oriented toward full technical responsibility by the Principal Investigator who functions under the direction of the Manager of the Process Chemistry Laboratory who reports to the Director--Process Technology Department. Teams of skilled technical staff members will work under the direction of the Principal Investigator to accomplish each assignment in a timely and competent fashion. Each task will be subdivided, when appropriate, into subtask units and assigned separate control numbers to facilitate prompt and orderly project execution, while maintaining realistic budget control. The Principal Investigator will define subcontractors' scope of work and provide technical direction to subcontractors and consultants.

The commitment and availability of FRC management to its sponsors has been an important factor in the success of past and current contracts. The Principal Investigator will provide most of the technical liaison related to the project. In his or her absence, or in the event any problem cannot be resolved at this level, the sponsor is encouraged to communicate directly with the Director of the Process Technology Department, or the Manager of the Process Chemistry section. They closely monitor the technical and fiscal performance of government contracts through regular internal reporting, and may be relied upon to respond quickly and directly to requests by the Sponsor.

8.2 ADMINISTRATIVE RESPONSIBILITY

The Manager of the Process Chemistry Section will have administrative responsibility for projects carried out during the contract period. He or she will ensure rapid response to EPA needs by providing EPA with outstanding technical personnel for task execution and by providing liaison with the business management groups of FRC, so that realistic project budgets and financial controls will be maintained.

8.3 FRC PROJECT MANAGEMENT SYSTEM

Successful project management requires attention to several factors:

1. development of a realistic plan and schedule;
2. adherence to the project schedule;
3. realistic project budget;
4. personnel assignments;
5. adequate quality of work;
6. early recognition of potential problem areas;
7. prompt diagnosis of problems and rapid, technically sensible solutions;
8. full communication and liaison between FRC groups, EPA officials, and other involved parties.

These factors are achieved at FRC by the utilization of well-defined systems and communication controls and channels and by the assignment of competent, experienced personnel to the teams working on the project tasks.

Depending on the complexity of a particular task, control of the project will be achieved by a combination of personnel-hour reports and a logic diagram to define and monitor project activities. When appropriate because of a complex task assignment, the logic diagram can be subdivided into component work items and personnel-hour task loadings can be established for each item. Finally, when necessary, an IBM Project Control System or equivalent, based on time expended versus the pre-established estimated expenditure rates, can be used to establish a critical path work schedule in order to facilitate ontime completion within budgetary restrictions.

The sum total of the application of these project management tools will be rapid response, technically competent results timely and adequate reports and other output, with proper attention to realistic budgetary limitations.

8.3.1 Project Documentation

Adequate documentation of any project is a necessity. For a multitask project such as that proposed, careful and complete documentation is particularly important, since many persons may be expected to become involved at various times during the project and they must be able to obtain a full understanding of their project responsibilities as quickly as possible.

Documentation must be centralized and backed up. Contracts administration personnel at FRC maintain a limited-access, central master file of all FRC contracts; each operating Department also maintains a complete project file.

Project documentation for the proposed project will include the following types:

Contract file - Copy of proposal, signed contract and modifications thereto, official contractual correspondence.

Expense file - Biweekly budget analysis printouts for labor and materials; reports for travel and incidental project expense; purchase orders, vouchers, etc.

Internal performance reports - Weekly progress reports containing narrative and statistical data prepared by task supervisors and summarized by the Principal Investigator.

Correspondence - Technical correspondence with the sponsor and external organizations arranged chronologically.

Travel and telephone reports

Task reports - Draft, interim, and final reports, organized by task.

Monthly reports - Narratives

Final reports

8.3.2 Fiscal Management

As part of its regular internal accounting and fiscal control procedures, FRC produces weekly computer printouts of all labor, overhead, and materials/supplies charged against each project. All project managers and supervisory personnel are trained in the analysis and interpretation of these reports and must correlate time charged by project personnel with their weekly productions; output is thereby determined to be commensurate with expenditure. Possible overruns are pinpointed in time to permit appropriate corrective measures to be applied. Our accounting system is set up to show commitment of project funds as well as costs actually incurred. For projects which involve more than one department or several cost centers, separate budgets are established, and each center is responsible for maintaining costs within budget.

8.3.3 Quality Assurance

(See Appendix D)

8.4 MILESTONE CHART

A milestone chart is given in Figure 8-1.

TIME SCHEDULE FOR PROPOSED WORK, PILOT UNIT CONSTRUCTION & OPERATION, AND PRELIMINARY DESIGN FOR, AND COST ESTIMATE OF, FULL-SCALE OPERATIONS

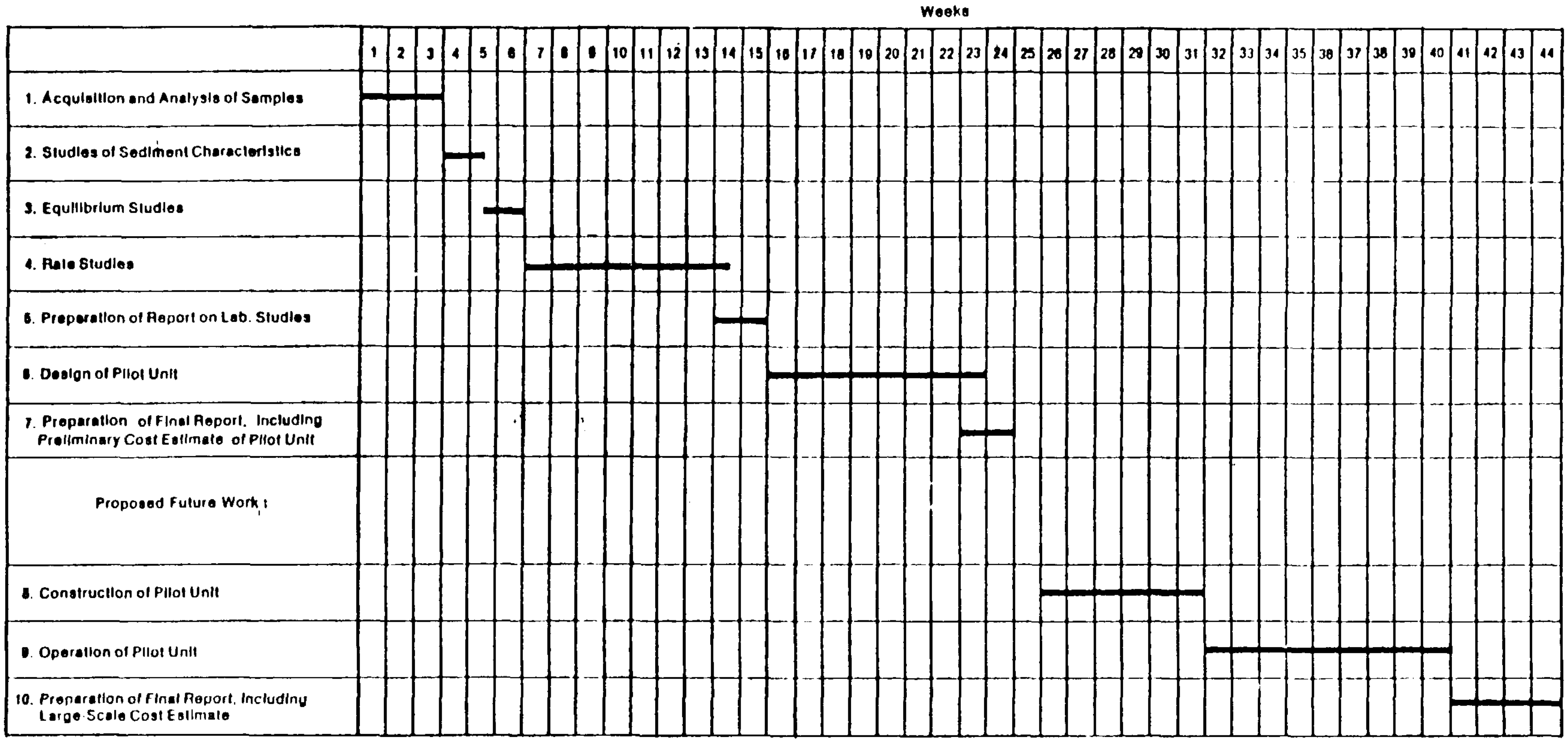


Figure 8-1. Milestone Chart

9. FACILITIES

Since 1967 the Franklin Research Center (FRC) has occupied a specially-designed, modern research center (shown in Figure 8-1) at 20th and Race Streets, Philadelphia, Pennsylvania. An organization diagram of FRC is shown in Figure 9-2.

The five-level building contains 151,000 square feet of floor space and incorporates advanced space-use features to provide one of the country's finest engineering/research facilities. Its location is convenient to all forms of public and private transportation.

FRC employs approximately 450 scientists, engineers, technicians and support personnel. The professional staff is housed in separate offices, typically with a senior member in a single room and two or three others in a double-sized room as shown in Figure 9-3. Most offices are on the perimeter of the building. These quarters provide the atmosphere and conveniences most conducive to scientific productivity and the free exchange of ideas.

The majority of the experimental laboratories are conveniently located adjacent to the appropriate staff offices and in the center of the building. Each laboratory is serviced with the necessary utilities as needed from central core raceways. Those laboratories requiring special floor structures, such as the optical bench in the Optics Laboratory, are located in the basement. Typical experimental laboratories are shown in Figure 9-4.

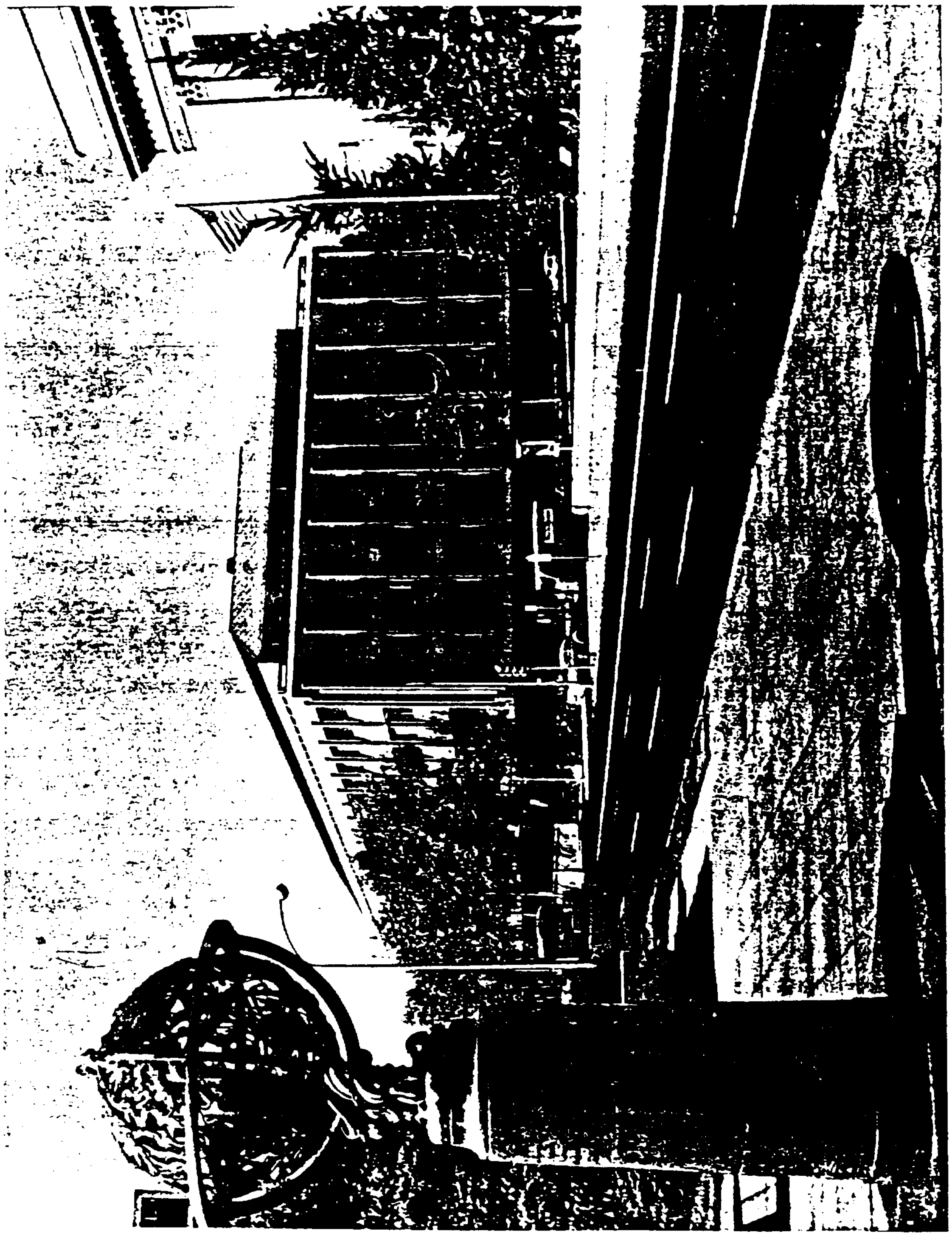


Figure 9-1. Franklin Research Center

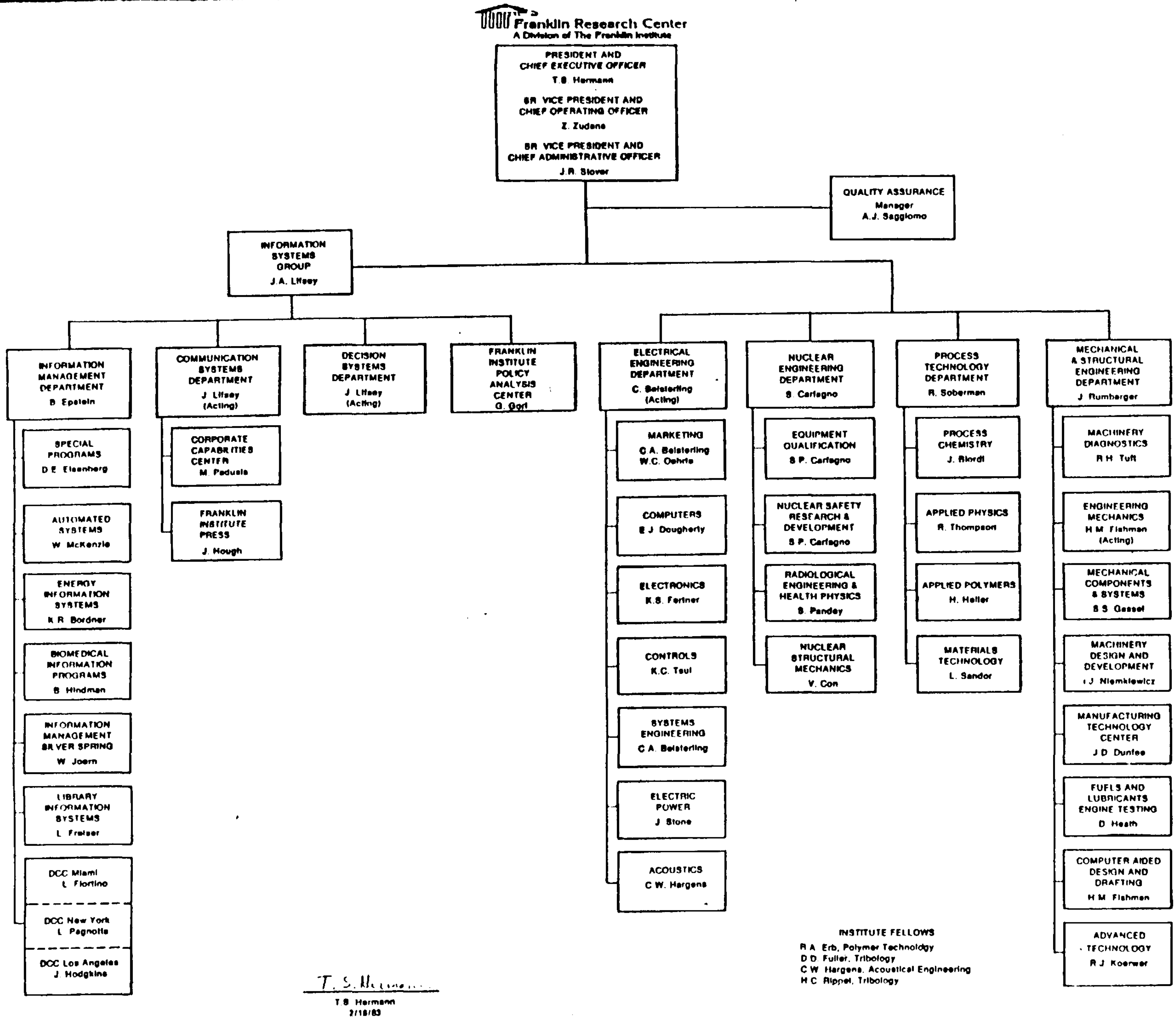
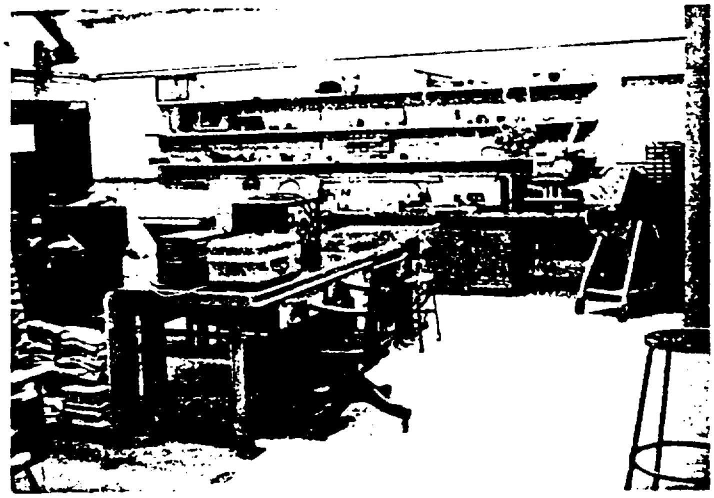
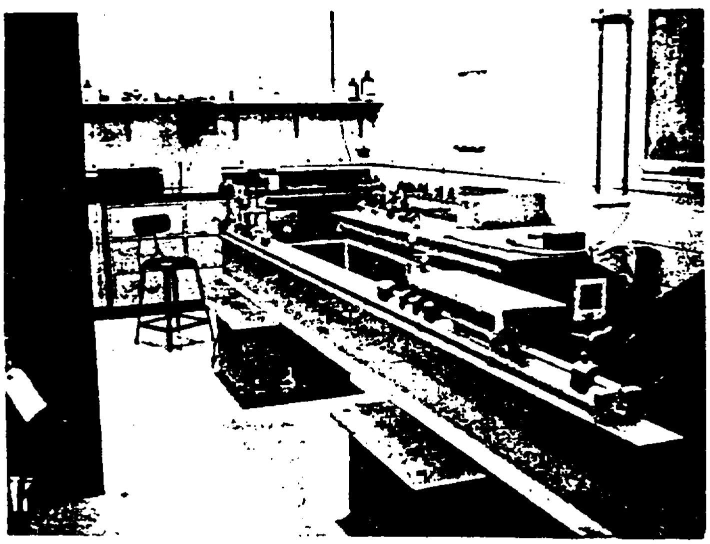


Figure 9-2. Organization Diagram for the Franklin Research Center

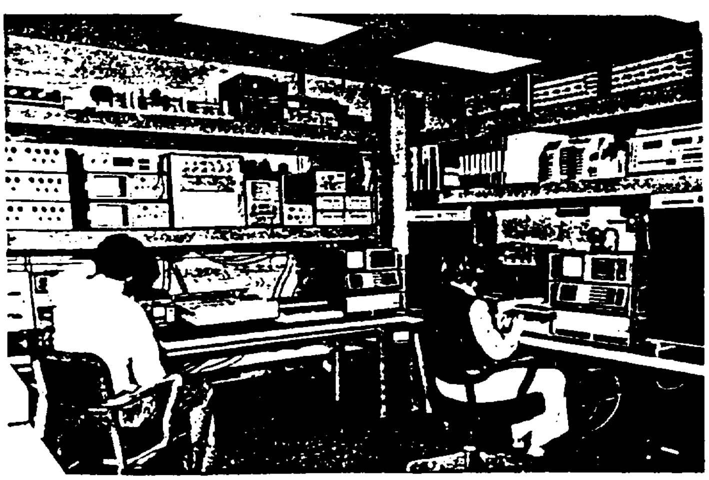
Figure 9-3. Typical FRC Offices



ELECTRONICS



OPTICS



MACHINERY DIAGNOSTICS

Figure 9-4. Typical FRC Laboratories

9.1 PROCESS TECHNOLOGY DEPARTMENT

Applied scientific research and development programs at FRC are conducted in the Process Technology Department. Project work is generally performed by ad hoc multidisciplinary teams recruited from this Department and from other FRC components. For administrative purposes, the Department is subdivided into several major sections, covering Chemistry, Physics, and Materials. Affiliated organizations, Thomas Jefferson University and Franklin-Hahnemann Institute, provide additional specialized capabilities in biomedical and environmental research areas.

Members of the Department, most with advanced academic degrees, are chemists, physicists, metallurgists, dentists, as well as biomedical, chemical, electrical and mechanical engineers. They work singly or together to solve technological problems, to perceive the needs of industry, society and government, and to introduce concepts geared towards novel problem solution. An organization diagram of the Process Technology Department is shown in Figure 9-5.

Research and development projects sometimes require an extension of fundamental knowledge and often are designed to develop new products or processes. Sophisticated or unusual testing is frequently involved, along with failure analyses, product evaluation, and consulting.

A listing of pertinent instrumentation for analysis and testing is presented in Appendix B.

9.1.1 Chemistry Section

Synthetic Chemistry Facilities

Synthetic chemistry activities are carried out in large, well-equipped laboratories, primarily devoted to:

Organic Synthesis
Inorganic Synthesis

Full instrumental and wet analytical facilities are located in separate, adjacent laboratories.

PROCESS TECHNOLOGY

600

R. Soberman
Director

601 PROCESS CHEMISTRY
Joan Biordi
Manager

- Hazardous Waste Treatment
- Analytical Chemistry
- Sludge Treatment
- Elverson Test Site
- Dental Sciences
- Medicinal Chemistry
- Pilot Plants

606 APPLIED PHYSICS
R. Thompson
Manager

- Explosives & Pyrotechnics
- Applications & Safety
- Electro-Magnetics
- Electrostatics
- Obscuration
- Energy

608 APPLIED POLYMERS
H. Heller
Manager

- Polymer Applications
- Prosthetic Materials
- Restoration and Preservation
- Hydraulics
- Cement & Concrete
- Paint Removal

609 MATERIALS TECHNOLOGY
L. Sandor
Manager

- Ferrous & Nonferrous Metallurgy
- Failure Analysis
- Welding and Joining
- Corrosion
- Radiation Safety
- Non Destructive Examination

12/1/82

Figure 9-5. Process Technology

In addition, several smaller synthetic chemistry laboratories, including a separate facility devoted entirely to hazardous chemical handling, are available for implementation of contracts.

The synthetic chemistry laboratories are fully equipped and stocked with a full range of glassware from microliter scale up to complete 22-liter glass apparatus.

These laboratories are in daily functional use with liberal excess capacity available.

Analytical Chemistry

Analytical Chemistry activities center on classical organic or inorganic chemical fields and include well-instrumented facilities for analytical chemistry. Recent projects include a range of industrial projects or product improvements, analysis requirements for new chemical syntheses and application of chemical phenomena to field applications. Also included is development of new instruments, such as the ion mobility spectrometer and other spectrometers, for detecting trace quantities of pollutants. A unique Mossbauer spectrometry facility is maintained for ultrasensitive analysis of specific, metallic compounds. A special team is experienced in analysis of hydraulic and lubrication fluids and in development of devices and techniques for detection and removal of impurities in operating hydraulic and lubrication systems.

Leading-edge gas chromatography-mass spectrometry instrumentation with full data system support is available in-house for both routine and nonroutine analysis of toxic substances, drugs, pollutants, and other organic and inorganic substances. Other nonroutine instrumentation includes high performance liquid chromatography, nuclear magnetic resonance and atomic absorption spectrometers.

A formal detailed quality assurance program is maintained and used on all analytical projects.

Mass Spectroscopy/Finnigan Model 4021 GC-MS-DS--FRC is equipped with a Finnigan Model 4021 system, capable of electron impact (E.I.) and chemical ionization (C.I.) modes of operation.

There is no doubt that Mass Spectroscopy (MS) is the most sensitive and universally useful single "ultimate" technique for analysis of low and high concentrations of compounds, and the Finnigan MS instrument is considered to be the state-of-the-art system available today. This FRC instrument is equipped with its specially designed GC unit and an extremely useful data system, the 2000 Series INCOS DS, which permits applying the full power of the INCOS software for data processing. The DS includes a 16-bit word CPU with 700 nanosecond cycle time and foreground/background system for simultaneous acquisition and processing of data. Creation of library spectra records and ability to compare them with sample runs is an extremely valuable feature for research projects, especially for periodic stability runs and for less-common chemicals, drugs and metabolites. Additionally, the FRC instrument is provided with the basic EPA/NIH/MSDC library for rapid assignment of probable structures of unknown compounds.

One further feature of the FRC GC-MS-DS system is its output capability. Hard copy and/or magnetic tape with controller and formatter are available in a dedicated Textronix/Wangco unit and are useful for permanent records of data and results.

High Performance Liquid Chromatography--FRC has a Waters Associates 244 Series High Performance Liquid Chromatograph (HPLC) with complete accessories, another state-of-the-art analytical tool. Included in this system are a dual UV detector, differential refractive index detector, and a computer-controlled, dual pump solvent programmer. The HPLC can be interfaced with the GC/MS if required.

HPLC analyses are extremely useful for separating and quantitatively measuring nonvolatile materials, even including many drug compounds; providing rapid, specific, sensitive analysis; and requiring only a few microliters of sample or biological fluid. The HPLC is a valuable adjunct to the GC-MS method.

Drug stability testing is a good example of the usefulness of our sophisticated HPLC system. For example, aspirin has been monitored for the major decomposition product, salicylic acid. It is possible to detect as little as 0.03% salicylic acid, an order of magnitude more sensitive than required by FDA specifications.

High-performance liquid chromatography/radioimmunoassay methods (HPLC-RIA) can be employed, if required, with data acquisition by a scintillation counter. Scintillation counting is performed by our nuclear chemistry facility, using an Intertechnique Model SL30 three channel liquid scintillation counter (LSC). This unit also has data handling capabilities.

Environmental Science

Environmental and Waste Disposal efforts cover a broad range of approaches for monitoring air, water and solid waste pollution. This research has included development of new methods and instruments. Staff scientists are familiar with accepted sampling and analysis technique. One currently active program covers extensive monitoring of asbestos in either water or air for a large number of sponsors. Another active program has resulted in the development of highway aggregate from incinerator residue and from municipal sewage sludge in an energy conservative process. Previous work resulted in development of porous pavement which in 1974 won a Special Recognition Award from the American Society of Landscape Architects. Environmental chemists at FRC have recently developed a promising environmental control material, NaPEG Reagent, that efficiently decomposes hazardous halogenated materials including PCBs.

Chemical Engineering

Chemical engineering work at FRC covers a range from bench-scale development of processes through pilot operations and demonstration plants. Bench-scale development is conducted in the main laboratory building in Philadelphia while pilot plant operations are carried out at the Elverson (Pennsylvania) Test Facility. Demonstration plants are built and operated at sites chosen by the various sponsors. Typical projects include:

o Development of chemical material for use in the destruction of chlorinated hydrocarbons

This project resulted in the development of a bench-scale procedure for producing a family of chemicals (NaPEG Reagents) which react with chlorinated hydrocarbons, including polychlorinated biphenyls (PCBs), to produce physiologically harmless materials. Subsequent to the bench-scale development, a pilot plant was constructed for the production of test quantities of the material (20,000 gallons/year).

o Development of solid waste treatment process for trash and sewage sludge to produce inert rock-like material for roadway subbase.

Excess process heat is used in predrying operations. The process was developed on bench scale followed by pilot production of test quantities for field evaluation. A large demonstration plant capable of producing 30 tons/day of rock is now in operation at a site in northeast Philadelphia.

o PCB treatment plant

Chemical engineering personnel worked with personnel of a local utility to set up and begin operation of a plant to treat transformer oil with NaPEG to remove PCBs.

o Fiber pipe impregnation process

A pilot plant was constructed and operated to demonstrate a vacuum/pressure process to impregnate fiber pipe with coal-tar pitch.

o Oxygen sensing electrode production facility

Personnel of FRC outlined a production process, designed the production line, and set up quality control procedures for the high-yield production of oxygen sensing electrodes for a local electronics manufacturer.

9.1.2 Physics and Materials Section

More than any other laboratory in the U.S., the Applied Physics Laboratory has developed fundamental and practical experience on the interactions of radio-frequency radiation and other electrical environmental phenomena with explosives and other materials. This knowledge has been used to develop protection against such environments as well as to determine and explain the behavior of electrical initiators and explosive field work in underground mines, military installations, airports and other transportation centers. Specialized electrical instrumentation has been developed for use by many organizations and government agencies. This laboratory also has broad experience with the use of explosives and has presented extensive training programs on explosives technology and safety. Static electricity, magnetism and laser optics are other areas of expertise. Additional physics research focuses on evaluation and reduction of static charges in spacecraft.

The work of the Applied Polymers Group centers on applications of plastics, fibers, elastomers and resins. This currently includes use of plastics in fabrication of effective low-cost collectors and other components for solar energy systems. Another product under development is a non-surgical system for fertility control that involves reversible blocking of fallopian tubes with specially formulated polymers. Other bio-materials include development of prosthetic systems and evaluation of rheology and mechanical characterization of biological materials. Additional polymer work includes rheological studies on paints and inks, formulation of silk-screening paints for textile printing and investigations of consumer fraud. A long-term program focuses on fundamental physical-chemical studies of cellulosic fibers and development of new composites for water absorption

The Materials Technology Section specializes in failure analysis, metallurgy, welding, and corrosion. The laboratory excels in relating the structures of materials to their properties. Among its recent accomplishments are cladding techniques to improve ship performance and the analyses of failures and their mitigation in fans, turbine blades, mining equipment and large power-plant equipment. Also underway are several programs on stress corrosion and on surface treatments to reduce materials corrosion.

Materials Characterization is supported by well-instrumented laboratories for mechanical testing and for analysis of microstructure by microscopy or by X-ray evaluation. The department is experienced in most of the conventional areas of materials testing and has frequently developed new equipment or procedures for special needs. One major recent program, for example, was evaluating impact tests for plastic glazing materials. Microstructure work includes a broad range of techniques in Section and optical microscopy and X-ray diffraction.

Welding and Metallurgy Facilities

FRC's welding laboratory is equipped for most of the standard welding processes. The equipment is now located in a separate facility with adequate provisions to handle large metal sections. Some of the available processes are: Submerged-Arc, Gas Metal-Arc, Gas-Tungsten-Arc. The Laboratory is staffed by FRC's Welding Engineering Staff that includes experienced specialists with field and academic (Ph.D.) credentials.

FRC's laboratories are fully equipped with standard testing machines. a recent addition is a Lawrence/Instron machine of 20,000 lb. capacity. This is an electrohydraulic device programmable to give both oscillating and ramp loading. In addition, we have a standard floor model Instron and a Baldwin Tensile Testor of 120,000 lb. capacity.

A new microhardness testers and standard Charpy V-notch impact testers are available. Two fatigue testers are in routine use: a Wiedemann Universal fatigue tester and a Krause Direct Stress Fatigue tester. The Instron/Lawrence tester is, of course ideally suited for low cycle fatigue. Dewars and furnaces extend the temperature interval for testing from liquid helium to 1000°C.

Nondestructive Evaluation

Franklin Research Center has established a Nondestructive Evaluation Laboratory. The primary emphasis is on Radiographic and Ultrasonic testing. Dye penetrant testing is also used routinely at the labs. We have field portable equipment in Ultrasonic testing and Isotopic Radiography. Equipment consists of Sonic Mark IV and I portable Ultrasonic Flow/thickness test machines, and portable thickness gauges. We are assembling an Iridium-192 isotope source and portable darkroom.

FRC designs ultrasonic transducers and standards as well as automated test equipment with the capability of computerized data collection and analysis.

There are, on staff, a level III (ASNT-TC-1A) inspector in Ultrasonic Testing and a level II inspector in Radiographic testing (soon to be upgraded to level III).

9.1.3 Elverson Test Facility

For research and testing that is best performed away from the urban location of FRC, the Process Technology Department maintains the Elverson Test Facility shown in Figure 9-6 which is located in an isolated, yet readily accessible area 45 miles northwest of Philadelphia, near the community of Elverson, Pennsylvania.

The site includes a main building (4200 square feet) housing offices and a drafting area, an electronic instrumentation laboratory, chemistry laboratory and support services. Housed in separate buildings are: a combustion test facility (1500 square feet) which contains a fully instrumented one million BTU/hr liquid fueled test boiler with a separate fuel processing area, and two modern chemical process plants.

The facility also includes a small machine shop, two high vacuum test chambers of 500 and 1500 cubic feet capacity, and a test firing stand, with separate control buildings, for high energy fuels testing. There is a full-time staff at the site including senior engineers, technicians and support personnel. These are augmented as required by scientists and engineers from FRC as required.

Typical projects carried out at the Elverson Test Facility include:

Combustion, flame and explosive testing

High energy propellants, liquid rocket motors and burners

Upper atmosphere rocket payload and marker design, construction and testing

Figure 9-6. Elverson Test Facility

Materials properties at high temperatures and high velocities

Flares, high brightness flame and emission spectroscopy

Plasma arc chemistry

Cyrogenic chemistry

Pilot plant design construction and operation

Chemical processes and flow systems

9.2 INFORMATION MANAGEMENT DEPARTMENT

The Information Management Department of FRC, formed in 1961, undertakes collection, organization, analysis, evaluation, and processing of knowledge in a wide range of scientific and technical subject areas for government and industry in the United States and abroad. Subject specialties of personnel encompass the physical, biological, and social sciences in addition to information science.

The background of the Information Management staff encompasses a variety of extensive information-processing services including: current-awareness screening and retrospective bibliographic searching of the world's published scientific and technical literature, using both manual and automated techniques; acquisitioning open literature and "fugitive documents" from domestic and foreign sources; cataloging, abstracting, and indexing these documents for input to computerized information systems and/or for publication in abstract journals; extracting, formatting, and computerizing data; information-system design and operation of information systems and clearinghouses; database development and update; thesaurus development and lexicographic analysis; index-program development; developing state-of-the-art reports; preparing camera-ready copy for publication; design and implementation of surveys related to user needs for scientific information services and products; design and conduct of economic and policy research projects for government and industry; researching and presentation of industrial marketing data; conference management and support; and marketing of scientific and technical publications developed in-house.

The particular experience of the groups comprising Information Management are summarized below.

The Information Services Department encompasses all data- and computer processing activities for Information Management. The in-house, full-time staff includes senior and junior systems analysts, computer operators and programmers, and key operators. The experience of the professional computer staff covers a broad spectrum of computer languages, equipment, and applications. Languages include COBOL, FORTRAN, PASCAL, BASIC, PL-1, QUIKJOB, RPG, and ASSEMBLER. In addition, Information Services has pioneered the development of unique text-processing applications.

The Franklin Institute Library (FIL) subscribes to about 3,500 current scientific and technical titles, maintains an extensive collection of 4,000 retrospective periodicals, and has a book collection of approximately 50,000 volumes. In addition to its excellent collection of primary journals, FIL also receives many of the abstracting/indexing journals in the fields of science and technology and offers technical services such as acquisition, cataloging, and circulation. Special emphasis is placed on comprehensive coverage in biomedical, chemical, engineering, and physical sciences. FIL also has excellent coverage of periodicals from all disciplines that are published in Eastern European and Soviet-bloc nations, many of which it receives on an exchange basis for the prestigious Journal of The Franklin Institute, and maintains affiliations with more than sixty local, national, and international libraries.

Members of the Health Information Program group conduct research and compile information in biological and chemical disciplines. This department includes, among other activities, two Cancer Information Dissemination and Analysis Centers (CIDACS) and the International Cancer Research Data Bank (ICRDB). The mission of the Health Information Programs Department is to disseminate information and to plan and implement innovative information products, services, and activities for the research community.

The Environmental Information Group is involved in the collection and synthesis of environmental information in such area as solid waste management, pesticides, air and water pollutants and control, hazard assessments and geothermal energy. Projects usually include screening, abstracting, and indexing the world's environmental literature to prepare technical publications.

The Special Programs group conducts projects involving user-need surveys and statistical data-collection techniques. Members in this department are experienced in safety and accident studies, evaluation and investigation of transportation systems, damage and repair assessments, field interviewing, and data reporting.

Staff members are administratively assigned to departments according to subject or functional specialty. However, special teams are assembled from the Information Management groups and from other FRC departments, to meet the requirements of each project. In addition, we can draw upon other FRC resources, including The Franklin Institute Press[sm], which markets and publishes a variety of journals, reports, and other materials; and the Franklin Institute Policy Analysis Center.

Information Management is equipped with extensive state-of-the-art facilities for collecting and processing information. Libraries in Philadelphia use specialized equipment and programs for selecting, reproducing and storing pertinent literature citations. An integrated data- and word-processing system at the FRC Philadelphia headquarters and the Silver Spring branch office includes a complex of word processing units, OCR scanner, phototypesetter, and DECSystem-20 large scale computer Online database searching of over 200 commercially available and restricted-access databases is conducted (over 1500 average connect hours annually) using a broad array of terminals and printers.

We can offer our clients quick access to a very wide range of both published and unpublished information through the combined capability of all the Information Management facilities; the broad range of in-house resources; and the special arrangements made for using other libraries.

9.3 DOCUMENTATION FACILITIES

FRC maintains a Publication Service Department to support the printing and reproduction requirements of the Center. Included in this group are an Editorial Group, a Drafting Department, Photographic Laboratory, and Reproduction Department.

The Drafting Department is staffed by experiended illustrators who work closely with scientific personnel to translate technical data into graphic representations. The illustrations include multicolor diagrams, equipment layout, mathematical plots and curves, molecular and atomic structure, physical effect profiles, renderings, and exaggerated drawings. In preparing illustrations for project reports, scientific journals and instruction manuals, the drafting staff has worked to stringent governmental and industrial specifications.

The Photographic Laboratory is equipped to provide support for research projects and studies. Work performed in the Photographic Laboratory ranges from micro- and macro-photography to detailed enlargements, from still photography to ultra-high-speed motion pictures, and from black and white to color and infrared sensitive materials and development and printing.

The Reproduction Department is capable of processing printing requirements for all except large-size and high-quality pbulications which are normally typeset and commercially printed. The equipment of the department includes:

NuARC 30" x 40" offset camera
A.B. Dick 360 offset press (2)
A.B. Dick 369 offset press
PMT Transfer unit for slides, overhead projections, and direct transfers
ITEK Electrostatic 175 platemaker
NuArc platemaker
Challenge punch
Cheshire 750 binder
GBC Cerlox binder
IBM Selectric typewriters with Greek, chemical, and mathematical typefaces

Underwood microo-elite typewriters
Ozalid blueprint typewriter
Xerox 9500 copying machine
Wang Word Processing System 140
Compugraphic Viedosetter Universal

9.4 FABRICATION FACILITIES

The FRC machine shop is equipped with standard, up-to-date tools and is staffed by approximately 25 skilled technicians. Many of the shop personnel have 25 to 30 years of experience in their craft.

The shop's work involves primarily the fabrication of experimental devices, special equipment, and prototypes. Tasks range from the construction of heavy, bulky equipment to the fabrication of precision instruments. The shop has demonstrated expert performance in making tools and dies and in converting the most complex designs to finished components and devices.

In support of various contracts, the machine shop has worked to the rigid specifications of governmental agencies as well as similarly strict industrial standards.

The equipment in the shop includes various lathes (ranging from jeweler's to 16"), milling machines, shapers, borers, drill-presses, grinders, precision micrometers and measuring devices, optical comparators, profiles and flats, and similar tools to fabricate mechanical and electronic equipment.

Proposal No. 23074-I

COST

ESTIMATE

Proposal No. 23074-G
April 12, 1983

BUDGET ESTIMATE

Period of Performance: 24 weeks

Direct Labor

Grade	Position Title	Person-Hr. Rates	Person-Hrs.	TOTAL
12	Sr. Research Engineer	$24.17	680	$16,436
10	Research Scientist I	16.78	460	7,719
9	Research Scientist II	14.10	240	3,384
5	Supervisor, Illustrator	10.07	40	403
4	Secretary	8.73	40	349
3	Technician III	8.06	48	387
	TOTAL ESTIMATED DIRECT LABOR			$28,678
	Overhead (118%)			33,840

Other Direct Costs

Materials and Supplies	$ 100	
Purchased Items	1000	
Subcontracting	5000	
Consultants	3000	
Travel	3000	
Telephone and Telegraph	200	
TOTAL OTHER DIRECT COSTS		$12,300
SUBTOTAL, DIRECT LABOR, OVERHEAD, ODC		$74,818
General and Administrative (10%)		7,482
TOTAL ESTIMATED COST		$82,300
Fee		8,230
TOTAL ESTIMATED COST INCLUDING FEE		$90,530

APPENDIX A

RESUMES OF PROJECT STAFF

F. J. Iaconianni

K. Krevitz

D. M. Kyllonen

P. A. Landau

Organic Chemistry
Inorganic Chemistry
Environmental Chemistry

FRANK JOSEPH IACONIANNI

PROFESSIONAL EXPERIENCE

Dr. Iaconianni, a Research Scientist in the Process Chemistry Section of the Process Technology Department, joined the Franklin Research Center (FRC) in July 1980. He has been involved in various sponsored research projects, particularly for the U.S. Environmental Protection Agency and the Electric Power Research Institute. Dr. Iaconianni was involved in the determination of the structure and reactivity of FRC's NaPEG™ reagents, which are used for the detoxification of PCBs and other hazardous materials. Dr. Iaconianni has also investigated physical methods, such as extraction and adsorption, for the removal of PCBs from contaminated transformer oils.

Before joining the Franklin Research Center, Dr. Iaconianni was a graduate student at Drexel University, where he taught general, inorganic and organic chemistry, and performed research in various areas including the synthesis of novel transition metal coordination complexes. His research advisor at Drexel, Dr. L. L. Pytlewski, is currently a Principal Scientist at FRC and the inventor of the NaPEG™ reagents and the corresponding NaPEG™ processes for PCB detoxification.

ACADEMIC BACKGROUND

B.S., Chemistry
Drexel University, 1977
Ph.D., Major: Inorganic Chemistry
Minor: Organic Chemistry
Drexel University, 1981

PROFESSIONAL AFFILIATIONS

American Chemical Society
Phi Lambda Upsilon

PUBLICATIONS

1. Mikulski, C. M., Harris, N., Sanford, P., Iaconianni, F. J., Pytlewski, L. L., Karayannis, N. M.: "Polynuclear Metal-Complexes Formed by Reaction of Diethyl Acetyl-Phosphonate or Diethyl Benzoyl-Phosphonate with Metal Chlorides," Abstracts of Papers of The American Chemical Society, 176 Sept. p. 57, 1978.

2. Iaconianni, F. J., Gelfand, L. S., Pytlewski, L. L., Mikulski, C. M., Speca, A. N. and Karayannis, N. M., "Picolinic Acid N-Oxide Interactions with 3d Metal Perchlorates," Inorg. Chim. Acta, 36, 97 (1979).

3. Mikulski, C. M., Unruh, J., Rabin, R., Iaconianni, F. J., Pytlewski, L. L. and Karayannis, N. M., "Poly(metal methylphenylphosphinates) from Metal Chloride Solutions in Methyl Methylphenylphosphinate," Inorg. Chim. Acta. 44, L77 (1980).

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7. Speca, A. N., Iaconianni, F. J., Gelfand, L. S., Pytleswki, L. L. Mikulski, C. M. and Karayannis, N. M., "Transition Metal Perchlorate Complexes with 4-Phenylpyridine N-Oxide," J. Inorg. Nucl. Chem., 41, 957 (1979).

8. Speca, A. N., Gelfand, L. S., Iaconianni, F. J., Pytlewski, L. L., Mikulski, C. M. and Karayannis, N. M., "2-Benzylpyridine N-Oxide Complexes with Transition Metal Perchlorates," J. Inorg. Nucl. Chem. 41, 283 (1979).

9. Pytlewski, L. L. Krevitz, K, Smith, A. B., Thorne, E. J. and Iaconianni, F. J., "The Reaction of PCBs with Sodium, Oxygen and Polyethylene Glycols," Proceedings of the Hazardous Waste Research Symposium, EPA-600/9-80-011, March 17-20,1980.

10. Mikulski, C. M., Harris, N., Sanford, P., Iaconianni, F. J., Pytlewski, L. L., Karayannis, N. M., "Reactions of Some Metal Chlorides with Diethyl Acetyl- and Diethyl Benzoylphosphonates," Dept. Chem. Phys., Beaver College, Glenside, PA, 19038, USA; J. Inorg. Nucl. Chem., 42(9), 1361-4, (1980).

11. Speca, A. N., Mikulski, C. M., Iaconianni, F. J., Pytlewski, L. L. and Karayannis, N. M., "Purine Complexes with Divalent 3d Metal Chlorides," Submitted for Publication.

12. Iaconianni, F. J., Pytlewski, L. L., Mikulski, C. M. and Karayannis, N. M., "8-Quinolinol N-Oxide Adducts with 3d Metal (II) Perchlorates," Submitted for Publication.

13. Gelland, L. S., Iaconianni, F. J., Pytlewski, L. L., Speca, A. N., Mikulski, C. M. and Karayannis, N. M., "Nicotinic and Isonicotinic Acid N-Oxide Interactions with 3d Metal Perchlorates," J. Inorg. Nucl. Chem., 42, 377 (1980).

14. Mikulski, C. M., Iaconianni, F. J., Pytlewski, L. L., Speca, A. N. and Karayannis, N. M., "Adenine N(1)-Oxide Complexes with Cobalt (II), Nickel (II) and Copper (II) Perchlorates," Inorg. Chim. Acta., 46, L47 (1980).

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Mass Spectroscopy
Mossbauer Spectroscopy
Environmental Chemistry
Chromatographic Systems
Analytical Instrumentation
Instrumental Design
Microbiological Systems
Water Analysis

KENNETH KREVITZ

PROFESSIONAL EXPERIENCE

Mr. Krevitz, a Research Scientist in the Environmental Chemistry group, joined the Franklin Research Center staff in 1978. He is engaged in biological and chemical projects, employing appropriate analytical methods. He is also involved in the design and implementation of radioactive detection devices related to Mossbauer spectroscopy.

As a research specialist at Drexel University, Mr. Krevitz conducted studies on plant and animal tissues to determine specific natural products qualitatively as well as quantitatively. He employed and developed various chromatographic techniques for the isolation of hydrocarbons, fatty alcohols, sterols, and other isopentenoids. Mr. Krevitz has developed batch and continuous culture systems for the study of bacterial yeasts and molds. He was also responsible for the supervision of graduate students and technicians at Drexel University's Biochemical Research Laboratory.

Mr. Krevitz was employed by the Philadelphia Water Department during his Drexel University cooperative employment assignment, where he was responsible for conducting chemical analysis of drinking water and waste water. He has also been involved in the continuing research study of the Delaware River Estuary System.

ACADEMIC BACKGROUND

M.S., Biology
Drexel University, 1978
B.S., Biology
Drexel University, 1969

PROFESSIONAL AFFILIATIONS

Member of Sigma Xi Scientific Research Society of North America

PUBLICATIONS

1) W.R. Nes, K. Krevitz, J. Joseph, W.D. Nes, B. Harris, G.F. Gibbons, "The Phylogenetic Distribution of Sterols," Lipids, 12, 511 (1977).

2) W.R. Nes, T.E. Varkey, K. Krevitz, "The Stereochemistry of Sterols at C-20 and Its Biosynthetic Implications," J. Am. Chem. Soc., 99, 260 (1977)

R&D Management
Chemical Safety
Process Development
Technical Management (Process)

DAVID M. KYLLONEN

PROFESSIONAL EXPERIENCE

Mr. Kyllonen has had considerable experience in research and development, particularly in its management, and in conceiving and developing new approaches to current problems.

His previous positions have included those of Assistant Research Director, Technical Manager of the Muskogee Division, Resident Engineer of the Western Office, and Head of the Sponsored Research Department of Callery Chemical Company. At the General Electric Company, his positions have included those of Manager of Advanced Materials Technology and Manager, Plastics Quality Engineering in the Operations and Evaluation Department of the Reentry and Environmental Systems Division.

Mr. Kyllonen has managed R&D programs of a diverse nature in boron hydride chemistry, carbothermic sodium process studies, advanced chemical propulsion, safety of chemical weapons, fire extinction research, and others. He developed a concept for quickly eliminating the disaster threat involved in a nerve gas spill. He also developed a method for the removal of NO_2 from waste gas streams and maintains a continuing interest in air- and water-pollution control problems.

As Technical Manager of a 38-million-dollar chemical plant, he staffed and headed a department of 20 chemical engineers and 40 chemists and technicians. He directed all technical aspects of start-up, control, and design modifications of that plant, which produced pentaborane under target cost.

Mr. Kyllonen designed and started up the NaPEG™ pilot plant at Franklin Research Center's Elverson Test Site. He has also worked closely with Philadelphia Electric Co. personnel in the design and testing of the PCB-decomposition demonstration plant at their maintenance depot.

3) W.R. Nes, J.H. Adler, B.C. Sekula, K. Krevitz, "Discrimination Between Cholesterol and Ergosterol by Yeast Membranes," Biochem. Biophys. Res. Commun., 71, 1296 (1976).

4) W.R. Nes, K. Krevitz, S. Behzadan, "Configuration at C-24 of 24-Methyl and 24-Ethylcholesterol in Tracheophytes," Lipids, 11, 118 (1976).

5) W.R. Nes, K. Krevitz, S. Behzadan, G.W. Patterson, J.R. Landrey, R.L. Conner, "The Configuaration of delta5,7,22-Sterols in a Tracheophyte," Biochem. Biophys. Res. Commun., 66, 1462 (1975).

6) Pytlewski, L. L. Krevitz, K, Smith, A. B., Thorne, E. J. and Iaconianni, F. J., "The Reaction of PCBs with Sodium, Oxygen and Polyethylene Glycols," Proceedings of the Hazardous Waste Research Symposium, EPA-600/9-80-011, March 17-20, 1980.

Environmental Chemistry
Polychlorinated Biphenyls
Chemical Processes

PATRICIA ANNE LANDAU

PROFESSIONAL EXPERIENCE

Ms. Landau is a Research Scientist in the chemistry section of the Process Technology Group. Since joining FRC in February of 1980, her activities have been concentrated on development of chemical processes in the area of environmental chemistry as well as the analytical methods to support these projects.

Specifically, Ms. Landau has been involved in application of FRC's NaPEG^{tm} reagents, which are used in chemical destruction and detoxification of Polychlorinated Biphenyls (PCB) and other hazardous materials. She has had extensive experience in the handling and analysis of PCB's and supervised a laboratory where the effort was devoted to the manipulation of toxic hazardous materials.

Other projects at FRC in which she has been involved include: analysis of formaldehyde in insulation materials; preparation and testing of epoxy thermoplastic paints; and synthesis of paper chemicals based on polyethylene mines.

Ms. Landau is a chemistry major graduate from the University of Delaware, with special courses in Inorganic Chemistry.

ACADEMIC BACKGROUND — B.S., Chemistry, University of Delaware 1979

PROFESSIONAL AFFILIATIONS — Sigma Xi, The Scientific Research Society of North America

American Chemical Society

APPENDIX B

Analytical and Test Equipment

The following is a list of analytical and testing equipment available for project studies in the process technology department.

Analytical Balances

Cahn Electrobalance
Fisher
Mettler
Sartorius
Torbal

Atomic Absorption Spectrometer

Perkin Elmer 460 Atomic Absorption/Flame Emission, with

HGA-2100 Graphite Furnace
Model 56 Recorder

Centrifuges

Beckman Model L Ultracentrifuge
International - Bench top
International - Floor Model
Sorvall Refrigerated

Gas Chromatographic Instruments

Hewlett-Packard 5700 with

Dual FID
Dual TCD
Effluent splitter for FTD
Electron Capture Detector (ECD)
Heated collection vent for splitter
Heated gas sampling valve
Heated on-column injection ports
Subambient cooling accessory (-50°C)
Temperature programming
3380 Reporting Integrator

Hewlett Packard 5730
Electron Capture Detector (ECD)
3388 Reporting Integrator

Beckman GC45 with

Dual FID
Temperature programming
Heated on-column injection

High Performance Liquid Chromotagraph

Water Assoc., Inc. Model #244, with accessories

Mass Spectrometer

Finnigan GC/MS/DS, Model 4021, with full accessories

Microscopes, Optical

Leitz Ortholux
Unitron Metallograph
Olympus Stereo-Zoom
Olympus Fluorescence Model BHA
Zeis-Metallurgical Microscopy

Microscopes, Electron

Scanning Electron Microscope - JEOL model JSM-50A
Transmission Electron Microscope - JEOL 100CX - STEM
Evaporator, vacuum-Denton Model DV-515
Sputter, Eteh Unit - 1
Lorenz Attachment for Magnetic Domain Studies
PGT 1000 XL Mini Computer
Moseley X-Y Plotter

Microtomes

LKB Pyramitome
LKB Ultratome
Reichert OM-2

Meters, Conductance

YSI
Selection of Cells

Meters - pH/Specific ion

Beckman Expandomatic
Orion 701

Mossbauer Spectrometry Facility

Nuclear Magnetic Resonance Spectrometer

Varian EM360A
Digital Signal Averager
Lock-Decoupler

Protein Sequencer

Beckman Sequemat

Scintillation Counting Equipment

Intertechnique LSC

Spectrophotometer Laboratory

Aminco-Bowman Spectrophotofluorometer

Phosphorescence accessory

Cary 14 UV-VIS-NIR
Cary 15
Gilford
Perkin Elmer 521 Infrared

ATR accessory (Wilks)
1 meter gas cells (2)
Reflectancs hot stage accessory (Wilks)

Ultra-High Vacuum

Vacuum Evaporators

Physical Property Measurement and Sample Preparation

Mettler Balances
Tukon Microhardness tester
Denton Vacuum Critical Power Drywer DCP-1
Osmite S Automatic Osmometer
Beckman pH Meter
JB4 Microtome

Mechanical Testing Equipment

Instron-Lawrence Low Cycle Fatigue Tester
Instron Tensile Tester
Baldwin-Southwark Tensile Tester
Wiedemann Baldwin Universal Fatigue Machine
Microstrain Devices

Other Test Equipment

Viscometer, Hakke RV3
Viscometers, Brookfield (2)
Film Thickness gauge, Microderm
Push-Pull Gauge, Chatillon
Fineness of Grind Gauge
Reflection-Transmission Color Densitometer, Kodak
Tensiome ter, Du Nouy
Impact Tester, Wiedemann 60 ft. lb. (max)
Hardness Testers, Rockwell (2)
Sieves, Tyler
Reflection Meter, WHY 670

Thermal Analysis Equipment

Dupont, Model 900

DSC (-) 120 to 600°C
DTA to 1200°C
TGA to 1200°C

MATERIALS PROCESSING AND PHYSICAL TESTING EQUIPMENT

Colloid and Polymer Processing

Colloid Mill, Gifford-Wood
Mixer, Hobart
Mill, Troy, Three Roll
Rubber Mill, Two Roll
Pebble Mill
Draw Down Bars, Boston Bradley (3 and 8 inch)
Draw Down Bar, Baker
Laboratory Extruder, Killian
Injection Molder, Minijector
Impulse Sealer, Thermoset
Ultrasonic Sealer, Bronson

EDUCATION	B.S., Chemical Engineering University of Michigan
PROFESSIONAL AFFILIATIONS	American Chemical Society American Institute of Chemical Engineers (Former Chairman of Materials Engineering and Sciences Division)
PATENTS	"A Cyclic Process for Production of Sodium Borohydride" "Method for Removal of NO_2 from Waste Gas Streams"

APPENDIX C - The NaPEG SYSTEM

C.1 THE NaPEG REAGENTS

The chemical reagents and related methods employed to dechlorinate organic chemicals are known as the NaPEG System. The system was developed by researchers at the Franklin Institute and has been shown to effectively dehalogenate a wide variety of aromatic and aliphatic halogenated chemicals that persist in the environment. Our most intense efforts have been to characterize and develope PCB destruction methods. The NaPEG System for dehalogenation of PCBs in mineral oil dielectric fluids has been demonstrated to EPA's satisfaction to be at least as effective as incineration for destruction of PCBs in transformer oil, with the advantage that the oil is reusable.

The NaPEG Reagents are a new class of compounds in which the essential ingredients are alkali metal complexes of polyethylene glycols and not simple alkali metal alcoholates. In the NaPEG reagents the alkali metal ion is held in solution as a "crown-ether"-like complex by the large polyethylene glycolate anion. PCBs and other halogenated molecules are uniquely soluble in the NaPEG Reagents. These qualities combine to give a single phase system in which the super concentration of anions readily displaces the halogen atoms on halogenated molecules resulting in the production of alkali metal halide salts, and organic molecules with ArO^- (phenoxide) and /or ArOR (ether) groups.

The useful solvent-reactants are those containing at least an $-O-CH_2-CH_2-O-CH_2-CH_2-OH$ group. The lowest molecular weight, effective solvent is diethylene glycol monomethyl ether (methyl carbitol).

Most early dechlorination studies were done using polyethylene glycol 400 (ave. molecular weight = 400) in which the predominant molecular species are: $HO-(CH_2CH_2O)_8H$ and $HO-(CH_2CH_2O)_9H$.

The NaPEG Reagents are a versatile class of compounds which vary in composition, chemical and physical properties. They are usable in open air systems and are stable during storage for years. They are easily handled, biodegradable, and non-explosive. A most important consideration is that the NaPEG Reagents are storable and readily transportable to problem areas. The fact that the reagent can be prepared beforehand has greatly facilitated subsequent experimental work, and the generation of applications to very critical, immediate problems, such as cleaning up PCB tainted dielectric fluids and PCB spills on ground soils and paved surfaces on site.

C.2 DEHALOGENATION OF ORGANICS USING THE NaPEG REAGENTS

Our experience with the NaPEG Reagents has involved a wide variety of chemical reactions. The most important of these deal with the conversion of toxic chlorinated organics into chloride ion and oxygen containing organic products. The initial experiments with PCBs showed that they are completely miscible with the NaPEG Reagents, and that subsequent dechlorination is unusually facile. In addition, a variety of other toxic halogenated organic compounds were tested for direct reaction with a NaPEG Reagent. Similar positive results were obtained for these compounds.

The detailed investigation of the dechlorination reactions of the NaPEG Reagents have centered on the decomposition of PCBs occurring in contaminated dielectric fluids and in spills on soils and other solid materials. FRC has recently received EPA approval for the process of in-situ dechlorination of PCBs in contaminated dielectric oils.

This section contains a brief summary of our work with direct reactions of PCBs and other halogenated organics, and of the NaPEG treatment of PCB contaminated transformer oil.

Dechlorination of PCBs and Other Compounds

In the early stages of our research, dechlorination studies involved mainly neat PCBs, such as the commercial Aroclor^{R} PCB mixtures and PCB oils, such as Inerteen^{R} (a mixture of an Aroclor^{R} and Trichlorobenzenes) and

Pyranol[R] (an Aroclor diluted with chlorobenzenes). Subsequent work involved treating PCB contaminated dielectric fluids such as transformer and capacitor insulating oils.

In addition to PCBs, we have also investigated dechlorination reactions using the following pure compounds:

1) Decachlorobiphenyl
2) 4 - Chlorobiphenyl
3) Hexachlorobenzene
4) Hexachlorocyclohexane
5) Pentachlorophenol (PCP)
6) Individual Isomers of Di, Tri, and Tetrachlorobenzene
7) 1 - Chlorobutane
8) 2 - Chloroethyl Methyl Sulfide

During the past four years of investigation of chemical methods of detoxification we have compiled a sizeable list of primary pollutants (and pollutant problem areas) through the published literature, personal contact with governmental and industrial people, close communications with the EPA, and from the news media.

A recent book by Michael H. Brown, "Laying Waste: The Poisoning of America by Toxic Chemicals" (Pantheon Books, 1980) reinforces other information. The prominence of halogenated derivatives in the litany of toxic chemicals is especially remarkable. Metals, cyanides, and a range of inorganic and organic products all pose horrendous toxic hazards but halogenated organics stand out as a class. The following is a list of compounds in addition to PCB's which have achieved national notoriety as pervasive, persistent toxic materials endangering almost every community in the nation:

- Agent Orange* (2, 4, 5 T)*
- Aldrin

*Compounds which have been dehalogenated using the NaPEG system.

- o Carbon tetrachloride
- o C-56 (hexa)
- o Chlordane
- o Chlorobenzene
- o Chloroform*
- o DDT*
- o Dibromochloropropane*
- o Dichlorobenzene*
- o Dieldrin*
- o Dioxins (CDDs)
- o Endrin
- o Heptachlor
- o Hexachloro-1, 3-butadine
- o Hexachlorophene
- o Kepone*
- o Lindane
- o Malathion
- o Methylene chloride*
- o Mirex
- o Orthobenzyl parachlorphenol
- o parathion
- o PBB's
- o Toxaphene*
- o Trichlorophenol*
- o 2, 4-D*

Although PBBs have not been investigated by our research group, it is expected that they are easily converted to NaBr and debrominated organic products. Similarly, Freons such as trichlorotrifluoroethanes, for example, are converted to NaF, NaCl and dehalogenated organics. Overall, the reaction products of the NaPEG systems should be, based on our experience to date, very soluble in water, and readily combustible if necessary.

*Compounds which have been dehalogenated using the NaPEG system.

In general, our experience with PCBs and other chlorinated aromatic compounds has been increasingly encouraging. Although significant dechlorination of these compounds was expected prior to testing, based on the chemistry of the NaPEG reagents, the extent of dechlorination observed under the mild reaction conditions of many of our experiments was unexpectedly high. The extent of dehalogenation of halogenated aliphatics, such as methylene chloride, trichlorothylene (TCE) and Kepone, should be much greater than that of typical aromatics, because of the greater facility of nucleophilic cleavage of the aliphatic carbon-chlorine bond.

All of the aliphatic chlorides tested to date for reaction with NaPEG Reagents underwent very rapid, exothermic reaction at room temperature, producing NaCl (or KCl) and dehalogenated organic products. Methylene chloride, for example, produced NaCl precipitate immediately upon mixing with NaPEG 400^{tm} at room temperature. 1 -Chlorobutane was similarly converted to the n-butyl derivative of polyethylele glycol and NaCl. 2-Chloroethyl-methyl sulfide, a simulant of "mustard" blistering agents, was converted to the substitution product (chloride replaced by the PEG anion), or the elimination (of HCl) product, depending upon the composition of the reagent and the temperature of the reaction.

Dechlorination of PCBs in Contaminated Transformer Oils

The NaPEG Reagents have been found to be extremely useful in removing PCB's from contaminated mineral oil dielectric fluids. In co-operation with a local utility company, FRC has reduced concentrations of PCB's as high as 7400 ppm in transformer oils to levels less than 2 ppm by treatment of the contaminated oil with NaPEG Reagents. This is not a simple extraction. In this process, the PCBs are converted to oil-insoluble dechlorination products by reaction with the NaPEG Reagents. The treatment is followed by recovery of clean oil using a simple separation technique.

Some of the more recent results using NaPEG 400 are listed in Table C.1. Additional NaPEG Reagent formulations that have not been tested with PCBs contaminated oils are expected to be superior.

Table C.1 Decontamination of PCB Contaminated Transformer Oils

Run	NaPEG Reagent, Grams	Contaminated Oil, Grams	Time	Temp.	Aroclor	[PCB] Init.	[PCB] Final
(1)	NaPEG 400 "N" and KPEG 400 "H", a 200 g Total	500	20 hr	120-155°C	1260	7400	2.3
(2)	Same as (1), 66g[b,c]	500	3-7	120-155°C	1260	500	2.5 -3.5[c]
(3)	NaPEG 400 "N"	(d)		155°	1260	7400	< 2
(4)	NaPEG 400 "N" 100 g,[b,e]	500	10	125°	1242	500	< 3

Notes:

a) One step addition of reagent to oil.
b) Reagent was added by a 3-step, countercurrent technique.
c) Experiment run three times under different, but similar conditions of time and temperature.
d) Large scale demonstration performed at Phila. Electric Co., Oregon Avenue Laboratory
e) High shear mixer used.

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APPENDIX D

QUALITY ASSURANCE

PROJECT

PLAN

(REVISION 0)

Andrew J Saggiomo

EPA CONTRACTING OFFICER (APPROVAL)	ANDREW J. SAGGIOMO QUALITY ASSURANCE COORDINATOR
	Robert N. Krapf ROBERT N. KRAPF QA/QC CONSULTANT
EPA CONTRACTING OFFICER TECHNICAL REPRESENTATIVE (APPROVAL)	David M. Kyllonen DAVID KYLLONEN PROJECT MANAGER

Proposal No. 23074-G

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D-1 QUALITY ASSURANCE PROGRAM

D.1.1 Nuclear Beginnings

The Franklin Research Center's Quality Assurance Program, as documented in the Quality Assurance Manual which has been enclosed for your review, was originally conceived as an integral part of our Nuclear Engineering service contracts with the Nuclear Regulator Commission and other nuclear industry sponsors. The Quality Assurance Program documented and implemented at FRC in the nuclear area should be indicative of our fundamental knowledge and sensitivity to the important role that quality has in all of our non-nuclear project activity as well.

D.1.2 Terms, Quality Assurance vs. Quality Control

It is relevant, at this point to make a distinction between two concepts — Quality Assurance and Quality Control. "Quality Assurance" is defined here as FRC's Total Program for assuring the reliability of data it produces. The Quality Assurance Program Plan is a document (This Appendix D) presenting the policies, objectives, manage-structure, and general procedures which comprise the total program. "Quality Control' refers to the detailed and specific procedures used to ensure the quality of data produced by a particular measurement activity. For example a Quality Assurance Program plan for laboratory instruments would state that calibration needs to be addressed as an element of data collection activities. It would not, however, give instructions about how to do this calibration; these instructions represent quality control.

As one reviews the QA/QC type activities described in this proposal you should be aware that the Franklin Quality Assurance Nuclear Program operates paper work wise within the framework of two legally constituted documents. The Franklin Quality Assurance Project Plan for this proposal (which is Appendix D) will use the same two legally constituted documents. These documents are; a second level-type procedure known as Quality Assurance Systems Documents (QASD) which is used to support quality activities that require inter-departmental coordination and a third level-type document known as a Quality Assurance Procedure (QAP) which is used to support those quality activities where a single organizational unit (department) is involved. The generation, control and maintenance of these documents is described in the Quality Assurance Administration Instruction No. 1-1. (See Quality Assurance Manual.)

D.1.3 Project Type vs. Level of QA/QC Activity

There are four basic types of projects which require sampling and analyses QA programs; planning, research or design, process control and regulation. The first step in developing a reasonable Quality Assurance Project Plan is to define as precisely as possible the work elements that are entailed in a project. This has been done in Section 5 titled "Flow Chart of Sequential Work Elements and Corresponding QA/QC Activities." This proposal describes a research/design type of project and of the four project types should be considered the least rigorous with respect to certain classical QA/QC Activities such as chain-of-custody, some elements of sample collection and preservation, and adherance to standardized analytical methods when other non-standardized methods are judged to be superior, at the time. Research type projects develop best in an atmosphere of controlled flexibility where full and complete documentation by the analyst and timely (usually daily) review of all data by the project manager and QA coordinator is required.

D-2 PROJECT DESCRIPTION

The basic project is one of characterizing the essential parameters of a semi-fluid system (oil/water/sediment) for use in designing an extractor system. This extractor system will be an in-situ one and in order to establish an engineering basis for its design, it will be necessary to develop through laboratory studies parameter information in the following areas:

1. Physical characterization of the sediment relative to its affinity for oil and water, settling speeds vs agitation intensity etc.

2. Chemical equilibrium characterization of PCB's with respect to the oil-sediment system.

3. Chemical extraction rate characterization of PCB's from sediment with respect to mineral oil.

D-3 QUALITY ASSURANCE POLICY

It is the policy of the Franklin Research Center that there shall be sufficient Quality Assurance Activities conducted during the course of a project, to assure that the collection of project reportable data will meet the credibility requirements of the sponsor. The immediate objective of the FRC Quality Assurance Program is to assure that the quality of data collected, reported or used in the course of the project is properly documented and that the data are sufficiently accurate and precise to meet the Quality Assurance Objectives of the sponsor.

To assure the proper level of Quality Assurance Activities during the course of this research project a Quality Assurance Program has been established, is documented as Appendix D of this proposal, and is implemented under the direction of the Franklin Manager of Quality Assurance. For this project, the Manager of Quality Assurance will here after be referred to as the Quality Assurance Coordinator (QAC).

D-4 QUALITY ASSURANCE ORGANIZATION AND RESPONSIBILITY

The organizational structure, functional responsibilities, level of authority and lines of internal and external communication for the management, direction and execution of the Quality Assurance Program is as generally illustrated in the Quality Assurance Manual for Nuclear Projects, Section 5, pages 2 and 3.

One distinct advantage of our Quality Assurance Program is the element of independence and relative freedom from the production pressures of schedule etc., by the Manager of Quality Assurance (QAC). This is due to the organizational structure whereby the Manager of Quality Assurance has direct reporting responsibility to the President and Chief Executive Officer of FRC. This situation you will recognize is the outgrowth of our Nuclear Quality Assurance Program as mandated by Nuclear Federal Regulation, (10CRF 50 Appendix B).

The Quality Assurance Coordinator is responsible for running, and does routinely run (3 sessions in last 6 months) structured QA/QC indoctrination classes to support both our nuclear and non-nuclear project activity.

The Quality Assurance Coordinator is responsible for establishing this Quality Assurance Project Plan and auditing for compliance.

The Manager of Quality Assurance shall report each year at a meeting of the president's staff on the state of the Quality Assurance programs both nuclear and non-nuclear.

All initial issues, subsequent additions and revisions to this Quality Assurance Project Plan shall be approved by those identified on the title page of this document.

D-5 Flow Chart of Work Elements and Corresponding Quality Assurance and Quality Control Activities

This section is intended to illustrate the proper level of quality assurance and quality control that will be applied to this project. For the ease of presentation and understanding a flow chart approach has been used. This proposal consists of two phases (I and II) and each phase has two parts, (A and B). A flow chart showing the major work elements of each phase and each part is presented, and done so in the approximate sequence in which they will occur. The corresponding Quality Assurance and Quality Control activities for each work element step is defined in brief form and where additional details are needed to enhance understanding and completeness, a page is referenced. It should be remembered that this is a QA plan and that the greater level of detail required to adequately describe the Quality Control activities will be accomplished by preparing Quality Assurance Coordinator approved, Quality Assurance Procedures (QAP's).

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FLOW CHART

OF

QA/QC ACTIVITIES

Phase I Laboratory Research

(A) Objective: Characterize the Affinity (Entrainment Potential) of the Sediment For Oil (Mineral) and Water.

Step No.	Work Element	Quality Assurance and Quality Control Activities
1.	Obtain Sediment Samples From Site	- Use Research-Type Bound Notebook to record all aspects of sample acquisition (See Page D-8). - Use Glass containers/teflon lids or equivalent to avoid contamination. - Use proper sample labeling.
2.	Receive and Store Sediment Samples at FRC	- QAP will Address: (See Page D-8) 1) Custodian Assignment 2) Material Inspection Requirements (Damage) 3) Information Inspection Requirements (paperwork) 4) Research-Type Bound Notebook Logging Requirements 5) Storage and Security Requirements.
3.	Prepare Bench Set-Up	- QAP will Address A Sample Tracking and Instrument Control System (See Page D-8) 1) Research-Type Bound Notebook Logging Requirements
4.	Saturate Sediment With Oil and Determine Amount of Oil Needed	2) Identify a Means of Controlling Notebook Pages, Computer Printouts, Chromatograph Tracings and Other Written or Printed Documents Relevant to the Sample Integrity.
5.	Add H_2O to Separate Oil From Sediment	3) Identify Standards Required and How Used for all Instrument Calibrations. 4) Identify the On-Going Instrument Control Methods For Assuring the Generation of Quality Data, (Accuracy, Precision, Completeness and Representativeness)
6.	Allow Mixture to Stratify	
7.	Decant Oil Layer and Determine Vol. Oil/Wt. Sediment Recovered	- QAP Will Address an In-House Systems Audit (See Page D-9) 1) Develop Systems Audit Check Sheet (SACS)

(B) Objective: Characterize the Bulk Properties of the Sediment Namely Settling Rates.

Step No.	Work Element	Quality Assurance and Quality Control Activities
1.	Obtain Sediment Samples from Site	- Same as Step 1 in Phase I (A)
2.	Receive and Store Sediment Samples at FRC	- Same as Step 2 in Phase I (A)
3.	Prepare bench Set-Up	- Same as Step 3 in Phase I (A)
4.	Add H_2O to Sediment and Agitate (Using Various Methods) to Achieve Complete Dispersion	- Same as Step 3 in Phase I (A)
5.	Allow Mixture to Settle (Recording Qualitative Observations vs. Time)	- Same as Step 3 in Phase I (A)
		- QAP Will Address an In-House Systems Audit (See Page D-9) 1) Development Sytems Audit Check Sheet (SACS)

(A) Objective: Equilibrium Studies.

Step No.	Work Element	Quality Assurance and Quality Control Activities
1.	Obtain Sediment Samples From Site	- Same as Step 1 in Phase I (A)
2.	Receive and Store Sediment Samples At FRC	- Same as Step 2 in Phase I (A)
3.	Mix Moist Sediment with Oil. Analyze Original PCB Content	- Same as Step 3 in Phase I (A)
4.	Allow to Stand and Periodically Agitate	- Same as Step 3 in Phase I (A)

5.	Withdraw Oil Samples at Regular Intervals	- Same as Step 3 in Phase I (A)
6.	Separate Oil by Centrafication	- Same as Step 3 in Phase I (A)
7.	Analyze for PCB Content	- Same as Step 3 in Phase I (A)
		- QAP Will Address an In-House Systems Audit (See Page D-9) 1) Development Sytems Audit Check Sheet (SACS)

(B) Objective: Rate Studies.

Step No.	Work Element	Quality Assurance and Quality Control Activities
1.	Obtain Sediment Samples From Site	- Same as Step 1 in Phase I (A)
2.	Receive and Store Sediment Samples At FRC	- Same as Step 2 in Phase I (A)
3.	Add Mixture of Sediment and H_2O to Extractor Analyzer Original PCB Content	- Same as Step 3 in Phase I (A)
4.	Continuously Agitate	- Same as Step 3 in Phase I (A)
5.	Pump Oil into Bottom of Extractor	- Same as Step 3 in Phase I (A)
6.	Withdraw Oil Layer Periodically	- Same as Step 3 in Phase I (A)
7.	Separate Oil by Centrafication	- Same as Step 3 in Phase I (A)
8.	Anaylze for PCB Content	
		- QAP Will Address an In-House Systems Audit (See Page D-9) 1) Development Sytems Audit Check Sheet (SACS)

D.5.1 Additional Description of QA/QC Activities

Phase I
Part (A)

Step No.	Additional Description of QA/QC Activities

1. There will be but two types of logbooks/notebooks. One will be the research-type bound notebook issued to each individual who will be doing work on this project and a logbook for each analytical instrument which will be used to define any maintenance activities that occur for the instrument. This logbook on instrument maintenance activity is a key element of our Quality Assurance Program and it therefore transends to all projects which use this instrument. All project activities, observations and results recorded by an individual in his bound notebook or in the instrument logbook shall be in ink. If an error is made the person may make corrections simply by crossing a line through the error and entering the correct information. Changes made subsequently are dated and initialed.

2. A Quality Assurance Procedure (QAP), will be written and ultimately approved by the Quality Assurance Coordinator (QAC). As a minimum it will address those items listed.

3,4 A Quality Assurance Procedure (QAP), will be written and ultimately
5,6 approved by the Quality Assurance Coordinator (QAC). As a minimum it
7. will address those items listed.

   1. The research-type bound notebooks will be used to document all activities on this project, especially all QA/QC related activities. These notebooks are preprinted with book and page numbers, and spaces for title of project, project number, analyst signature, witness signature and dates. Each report sheet has a detachable duplicate sheet that allows up-to-date review by management (the Project Manager and Q.A. Coordinator) without disruption of the notebook in the laboratory.

   2. This Quality Assurance Project Plan (Appendix D) and in particular this QAP has two primary functions. The first is to continually monitor the reliability (accuracy and precision) of the results reported; i.e., they should continually provide answers to the question "How Good (accurate and precise) are the results obtained?" This function is the determination of quality. The second function is the control of quality (to meet the project requirements for reliability which for this research project is, "as good as possible"). As an example of the distinction between the two functions, the processing of spiked samples is a determination of measurement quality, but the use of analytical grade reagents is

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a control measure. In theory, each data collection activity (instrument used) should be documented with its quality control procedure.

The accuracy of data shall be determined, documented, and reported provided that certified reference materials are available or that measurements can be traceable to a national standard.

The precision of data shall be determined, as required, on a routine basis, documented and reported to the Project Manager and Q.A. Coordinator.

For this research orientated project the completeness and representativeness of the data generated, be it chemical or physical will be fully documented and assessed as an integral part of this project's review.

A Quality Assurance Procedure (QAP) will be written and ultimately approved by the Quality Assurance Coordinator (QAC). As a minimum it will address the item listed.

7.+ The Q.A. Coordinator or his designee will run at least one systems audit at approximately the three-quarters point of the project. A system audit check sheet (SACS) will be developed and legalized by using the QAP format. It shall be approved by the Manager of Quality Assurance. The purpose of the audit will be to verify that the laboratory is maintaining the necessary level of experienced personnel committed to the project, necessary level of instrument maintenance and analytical control (including accurancy, precision etc.) and the necessary level of full documentation of all experimental task activities, in particular sample description and tracking integrity.

In Summary

It is the responsibility of the Project Manager to assure that all QAP's which are needed are available for use in a timely way. For example, it has been highlighted on the flow chart of work elements that as many as three QAP's may be needed; one on sample receipt control, one on sample tracking and instrument control and one on in-house systems audit.